Chemical Age

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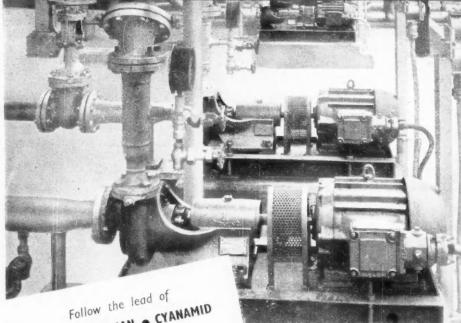
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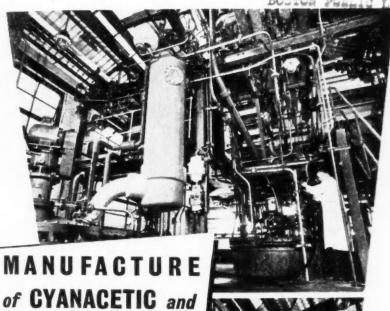
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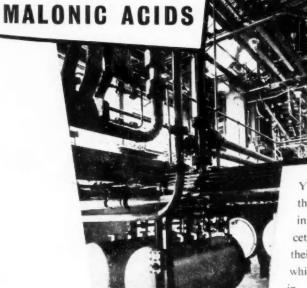
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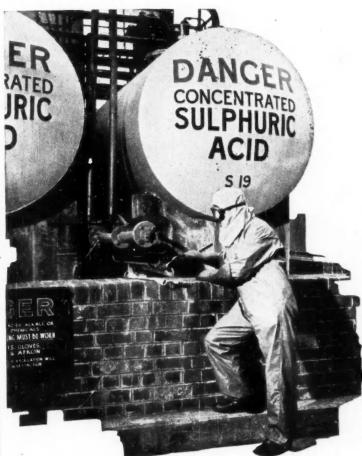
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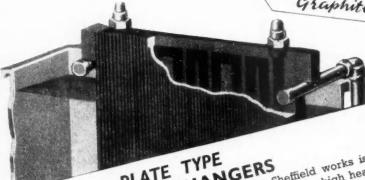


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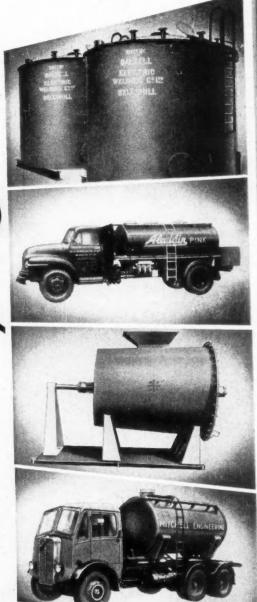
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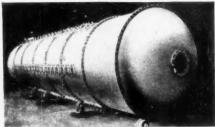
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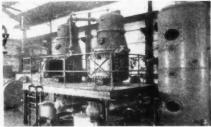
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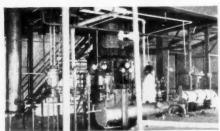
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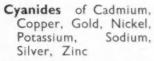
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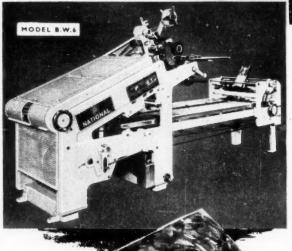
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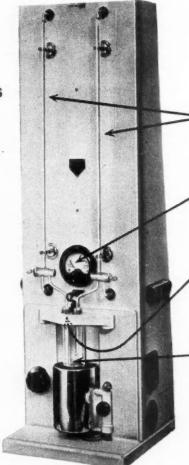
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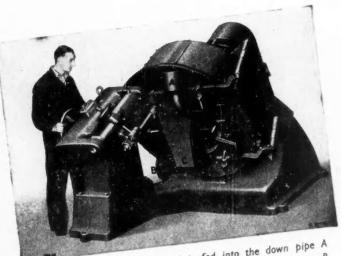
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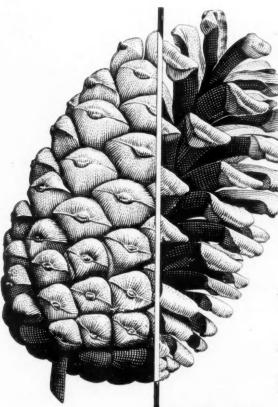
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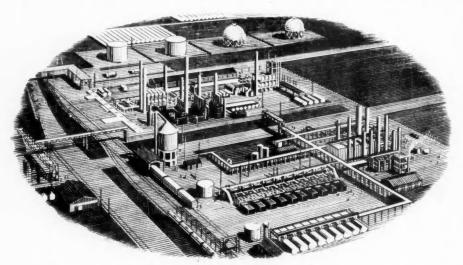
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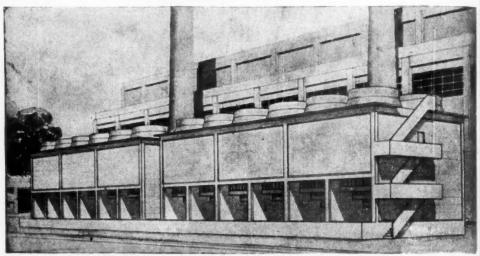


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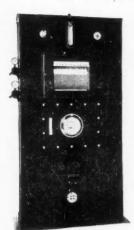
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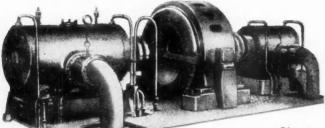
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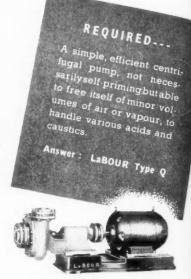


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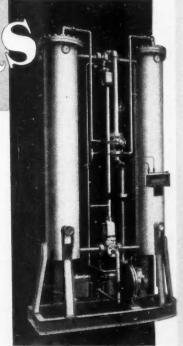
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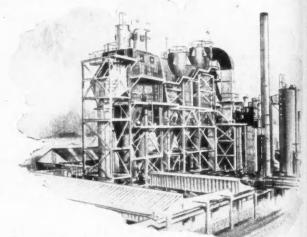


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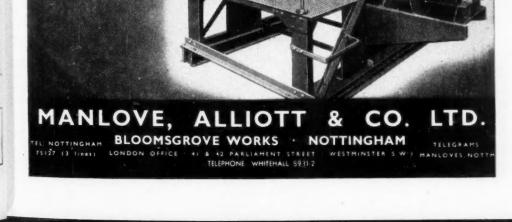


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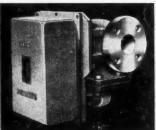


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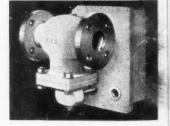
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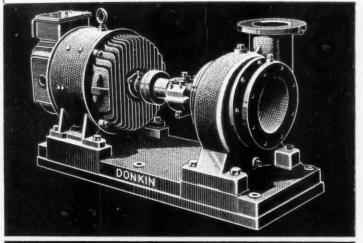
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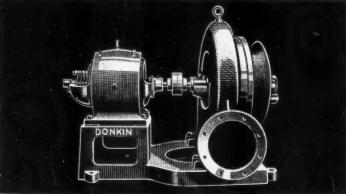
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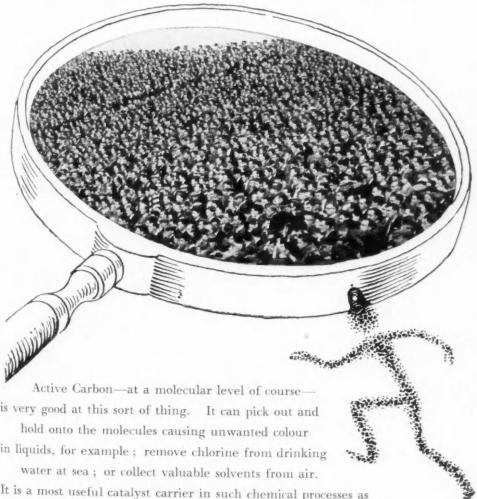
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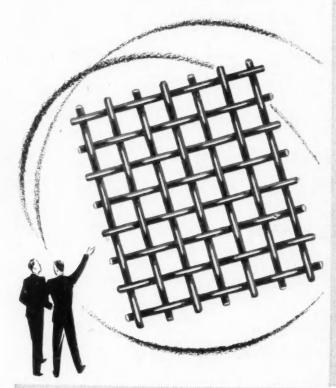
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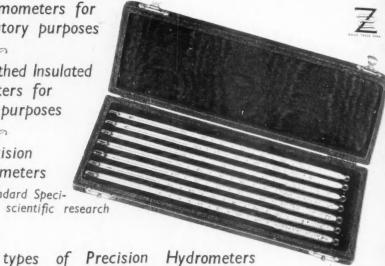
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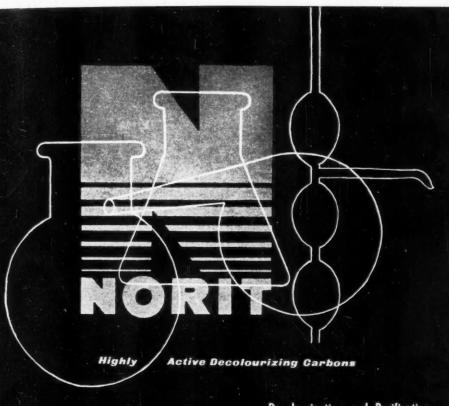
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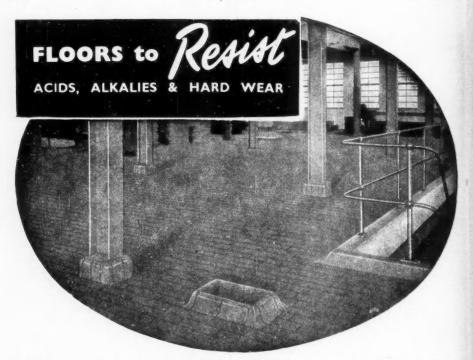
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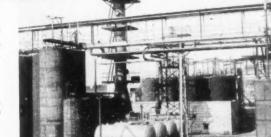
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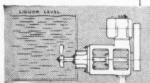
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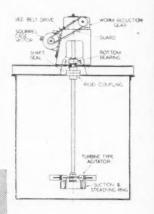
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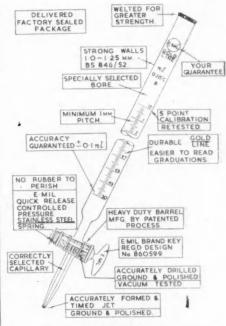
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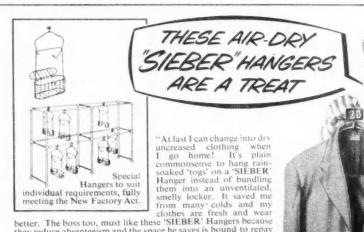


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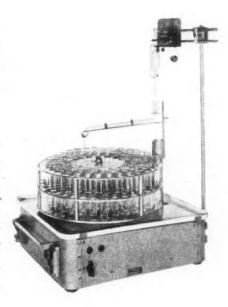
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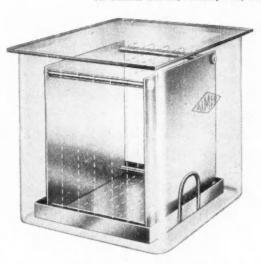
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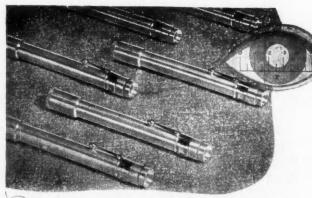
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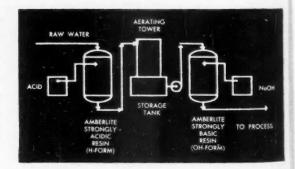
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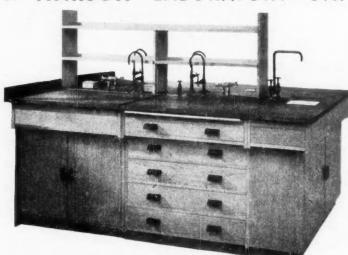
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The Chemical Age

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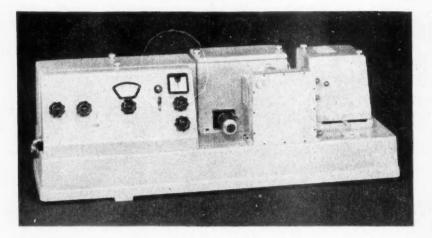
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Another Year

7 HETHER it is an entirely sound custom to sum up the past year and try to assess a new one just when the days are shortest and sunlight scarcest might well be debated. probably easier to be optimistic on the other side of the world where the calendar change falls in midsummer. However, this customary milestone of contemporary history has been long accepted and the industrial journal that marked the occasion with no more than small-print changes in vear-date and volume-number would be dodging the duty that every reader is assumed to expect. This somewhat diffident approach is perhaps to be principally explained by the fact that your commentator sensesinstinctively more than logically—that the task at this particular year-change is more difficult than it has been before. The chemical industry can look back with great satisfaction upon the steady progress of 1954; there are few signs that trade and technology will not maintain the same rate of expansion and improvement during 1955. And yet-? Is there a catch somewhere? Is it normal to count upon so much stability and prosperity? Only yesterday we were switchbacking from one economic crisis to the next. How sound is our new-won soundness?

Yet to voice these gloomy questions is to fly in the face of the evidence. The dollar problem is still with us but its malignance has faded; it is something we have to watch in much the same way that an athlete must watch a weak tendon—but given due attention it seems unlikely to create new troubles for us. The delayed revival of German industry is no longer some dark and unknown factor

of the future; that revival is largely an accomplished fact and the effect upon our own post-war expansion of exports has been surprisingly small. The diverse world market for chemical goods has expanded so much that there is plenty of room for a powerful chemical industry in both Britain and Germany, Even the optimists seem to have underestimated the potential demand for chemicals, hidden for so many years by sheer scarcity of supply. And where we have gained markets or greatly enlarged them in the earlier post-war years, we seem able to hold on to them despite the arrival of much more competition.

Two years ago the cautious observer might well have discussed the danger of a trade recession in the United States. There more than anywhere else the starting-point of a chain reaction seemed something of a risk. There was in fact a miniature recession. It was easily absorbed by the US economy. It was beneficial to Britain and other European countries because it was accompanied possibly in time-coincidence as much as in consequence—by useful falls in the prices of major raw materials. We gained considerably, the adverse effects were Today there is much less negligible. talk about recession on the other side of the Atlantic; unless the financial experts and economists who dwell upon these matters are all floundering, we need not raise the spectre of American recession for 1955.

In a general sense there are no obvious dangers of an external kind likely to threaten British industry's prospects in 1955. The tide of active prosperity can be reasonably expected to continue. If

there are predictable dangers, we must hunt for them internally. At the time these words are being written one danger of this kind is indeed among the imponderables of early 1955. A rail strike may be called-or last-minute negotiations may avert it. Should it start it will hamstring the system of distribution far more seriously than the docks strike of later 1954. Factories whose improved productivity has been the mainspring of our economic recovery will be unable to move much of their output. Foreign buvers will once again be plagued by slow deliveries from Britain and competitors will not be slow in seizing their opportunities.

Once again an over-all risk to industry arises from a state of unrest in one of the nationalised industries. Yet in this case it is hardly a convincing argument to tell railway workers that they will damage our new prosperity and recovery if they strike, for the cause of their unrest is that they themselves are far from prosperous; they have been told that the further part of their wage-increase demand cannot be offered because the nationalised industry cannot pay it, and they have also been told by the Government that a subsidy to the railways cannot be considered. It is easy enough to say that there ought not to be a rail strike. Wisdom may well have prevailed by the time these comments appear in print. But there has been in any case this threat of far-reaching dislocation It should have emand disturbance. phasised a serious disability in our present economy-prosperity, like peace, Full employment has is indivisible. probably never been fuller; but it is a condition that aggravates the grievances of any under-paid section of the country's workers. To say this is not to take sides in a prospective strike; but it may be a better form of wisdom to try to understand its causes than to condemn its consequences. There is nothing sudden about the unrest in this vital service. It has been brewing for all to observe for several years. Can problems as fundamental as these be solved piecemeal and on a make-and-mend system?

Our industrial recovery is not so long established that any strike can be afforded. It is a recovery that has

brought at least the semblance of prosperity to many sections of the nation. We risk the whole recovery and may lose for a long time all its prosperity if the benefits are not reasonably shared out. The old threat of inflation and the series of devices that was used to control it have left a number of difficult legacies, and not the the least of these is the problem of the skilled workers' reward for his special services.

Another challenge that is part of the new 1955 scene is the problem of 'takeover' bids, again a legacy from past restrictions. Years ago when large companies absorbed smaller ones, the process was stimulated by a lack of prosperity in the smaller unit, a deficiency likely to be remedied if it could be based upon a larger foundation. Today, the stimulus is given by prosperity, and the very conditions that should justify long-continued independence of operation bring the 'take-over' bid. It is difficult to imagine anything that is more artificial and illogical—but it has been bred by artificiality. No company is able to revalue its assets in the full terms of their changed worth; bonus issues of shares are permitted only on a limited scale, and although there have been increases in most dividend rates the extent to which this has been 'tolerated' in no way reflects the reality of share values. It is into this scene of artificiality and under-valuation that the take-over bid device projects itself. It is understandable, it is unavoidable, but it is also regrettable. When an industry is so actively prosperous, it is a tragedy that diversity and independence should dis-Yet any further freedom for appear. realistic valuation of assets must seemingly incur political displeasure, with workers protesting that fortunes are being made at their expense. The less obvious manipulation of the take-over bid attracts less censure. This might indeed be a crucial problem of 1955. If the Government is not prepared to permit the unrestricted revaluation of shares, there is much to be said for expanding the range of restriction and illegalising the device of the take-over bid. We are better off as a nation of many businesses. and mergers are justifiable only when they are to bring prosperity into being

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Notes & Comments

Anniversaries of 1955

ACH new year brings its anniversaries, and 1955 is an unusually rich year for those concerned with fundamental chemical theory. It was in 1855 that Pasteur put forward the socalled vitalistic theory of fermentation, a major turning-point in both biochemistry and applied chemistry. His other contribution of 1855 is probably less well known, but he then threw out the suggestion that optical activity of substances is due to some asymmetry in their molecular pattern. This was based on a study of sodium ammonium tartrate crystals. However, it was not a line of thought that Pasteur himself followed up, but within 20 years other chemists, including van't Hoff, had developed the idea and produced the spatial theory for atomic arrangement in molecules. As for bi-centenaries, 1755 is an outstanding chemical 'date' for it was then that Joseph Black's classic experimental work demonstrated the difference between 'mild alkalis' (carbonates) and 'caustic alkalis' (the oxides). Black virtually discovered carbon dioxide as a specific entity even though he could merely call it 'fixed air'. Almost coincidentally the French chemist Proust was born in the same year, and later he was to establish the all-important Law of Constant Proportions, a fundamental principle of chemistry that schoolboys can easily absorb now but which met with considerable resistance from chemists of the late eighteenth century. Black's work on the carbonates and Proust's law were from the same stables and each in its own time brought modern chemistry much closer. Another centenary of 1955, though not a particularly theoretical one, is the isolation of lithium by Bunsen and Matthiessen by electrolysing the fused chloride, mentioned in last week's issue (p. 17). This lightest of all the metallic elements is prepared for its modern commercial uses by much the same process that was used then. And inasmuch as diamond jubilees may be enjoyed by great events as well as by persons, it is just 60 years since Röntgen's discovery of

X rays. Can there be as many anniversaries of great 1955 events in 60, 100, or 200 years' time? Despite the enormously greater application of man-power and resources to science, it seems doubtful.

Having a Knock . . .

ANUFACTURING capacity for lead tetra-ethyl in the western world is about 650,000,000 lb. a year, and in Great Britain production is now at an annual level of at least 80,000,000 lb. During October nearly 8,000,000 lb. of this important chemical was exported, bringing in receipts of £1,048,566, a record for this one commodity, and over 6 per cent of the total value of exports for the month. These achievements can be attributed directly to the recent erection of a large new plant on Merseyside for the production of lead tetraethyl, and its associated ethylene dibromide plant at Amlwch in Anglesey (see THE CHEMICAL AGE, 1954, 70, 1093). This is news; this is success of which all Britain can be proud, and which all the world should know of. In the course, therefore, of preparing this annual review number, it was decided to include a photograph of one of these new plants, as a permanent record of one of the major chemical engineering projects of the past year. An executive of the company was telephoned; he laughed in an embarrassed way; he was sure we would understand, but they didn't want any publicity, they didn't want the public to take an interest in their activities, against their better judgment they had recently allowed some news of their Amlwch plant to be published, and that was all there would be. He was politely sorry, and he was sure we understood.

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BUT we do not understand, and it seems unlikely that we ever will. Why should this very large and very important company, producing a substance essential to the internal combustion engines of the world, be not only lacking in any desire for publicity, but actively opposed to it? Prosperity is a

national interest, and the achievements of a company which contributes so much toward that prosperity make news for the most untechnical citizen. Why then has this company so little faith in the public of Britain, which it serves, and on which, ultimately it depends? The days of industrial autocracy are past; no longer can any firm afford to ignore the people at its gates, anxious to learn, but equally anxious to help—for all our fortunes are bound up together.

Inventions and Industry

WHILE there exist a number of consultant chemical engineers capable of giving the most excellent technical appreciations of specific problems in the chemical industry, there has been a lack of organisations which can provide an effective link between inventors and patentees of new chemical processes and potential users, and an effective link between both parties and potential investors.

Industrial and Technical Services Ltd., working from a small group of specialist chemical engineers—qualified particularly in the fields of distillation, corrosion problems and problems of pumping, centrifuging and clarification—has also established relations with many of the more important organisations engaged in the development of new chemical processes and has a close connection with an industrial finance trust. It is the aim of this set-up to assist those interested in the development of new chemical projects in obtaining the most up-to-date chemical processes on the most favour-

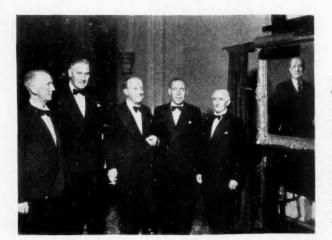
able terms and also the necessary specialised equipment to work these processes.

The association of Industrial and Technical Services Ltd. with an industrial finance trust also enables them to make economic appreciations of new projects and to indicate the best way of financing such projects where outside investment is required. At the same time Industrial and Technical Services Ltd. and the group with which it is associated can give assistance to inventors of new chemical processes in the commercial exploitation of their inventions.

German Patents in Canada

A NEW Canadian company specialising in the design and construction of chemical plant has been formed. The new firm Chemiebau Canada Limited, brings together the technical knowledge and engineering experience of the Foundation Co. of Canada Ltd., Montreal, and Chemiebau Dr. A. Zieren GmbH of Nieder-Marsburg. Germany.

The company, with its head office in Montreal, will specialise in the design and construction of complete plants for production of sulphuric acid, sulphur, soda ash caustic soda, hydrochloric acid, pure hydrogen chloride and other chemicals by processes developed and patented by Chemiebau Zieren. It will supply the chemical and engineering service necessary for either the development of a complete plant or for the alteration, modification or expansion of existing plants including conversion for treatment of other raw materials.



As reported last week (see p.38), Mr. Harold J. Cotes, managing director of British Glues & Chemicals Ltd., was recently presented with his portrait to mark 50 years in the glue industry. Shown in our picture with Mr. Cotes (centre) are, from left to right: Messrs. H. Groom, J. L. Fenton, G. T. Finney and B. S. Adderley. Each of these gentlemen has served under Mr. Cotes for over 40 years

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GREETINGS ...

W. J. WORBOYS, B.Sc., D.Phil.

(Chairman, Association of British Chemical Manufacturers)

EVERY industry is the better for an inde-pendent technical and trade Press, as much to criticise its shortcomings as to proclaim its achievements. The British chemical industry is fortunate to be sustained by



such a Press, and it is my privilege, as chairman of the Association of British Chemical Manufacturers, on behalf of our members, to extend to THE CHEMICAL AGE our thanks for its support during the past year and our best wishes for its success and prosperity future.

This is the time of year when men traditionally take stock of the past and make resolutions for the future. What of the year that now opens before us? In this connection I should like to offer three thoughts for the serious consideration of all who are concerned in shaping the destinies of our great chemical industry.

Firstly, although we can look with satisfaction to a rate of development in the last five years which is twice that of manufacturing industry as a whole, we should not regard this situation with complacency. A lesser rate of growth in an era that saw such a great expansion of chemical science and manufacturing technology would have been deserving of criticism. It must be our objective to show an even higher rate of progress in the next decade.

Secondly, let us resolve to try to arrange a freer interchange of experience between firms in the chemical industry. It can be achieved, I am sure, without serious risk of leakage of confidential information and, if

achieved, it should benefit all concerned and accelerate the growth of our industry.

Thirdly, let us face up to the increasing competition in the world's markets. cannot, on the one hand, complain that the overseas buyer says he chooses German chemicals because he knows they are good, and at the same time be rejuctant to demonstrate, by all means that lie to hand, the quality of our wares and the efficiency of our service. We must seize every opportunity to proclaim the name and fame of British chemicals throughout the world.

W. J. HOOTON, A.M.I.Mech.E.

(Chairman, British Chemical Plant Manufacturers' Association)

I AM happy to take this opportunity as chairman of the British Chemical Plant Manufacturers' Association to extend New Year greetings to all our friends in the

chemical and allied

industries.



Our industry had a good year in 1954, during which it maintained its important contribution to the national economy as a supplier of equipment to the British chemical industry (this being as always its major responsibility) and as an exporter of

British engineering products.

At the same time the export markets have not been neglected, as indeed they must not, and mindful of the necessity further to increase our industry's exports, directors of many BCPMA members have made extensive overseas tours during the past year. Also more members than hitherto exhibited overseas; some showed at the Baghdad Fair, while

.... from Chemical Trade Leaders

among the best plant exhibits at the recent Vochema at Utrecht and III° Salon de la Chimie in Paris were those of British firms. I look forward to a growth of such enterprise in 1955.

In an industry such as ours it is difficult to measure progress annually, but looking back just a few years one can see clearly how much the industry has grown, and, furthermore, this growth has been accompanied by an increased spirit of co-operation within the industry and between the industry and its customers. I am happy, therefore, that the British chemical plant industry can face 1955 with confidence in the knowledge that it is better equipped than ever before—in technological staff, design facilities, fabricating shops and skilled workers—to meet the demands to be made upon it.

On behalf of the Association and the industry it represents I wish THE CHEMICAL AGE every success and prosperity in 1955.

DOUGLAS WILSON

(Chairman, Council of British Manufacturers of Petroleum Equipment)

A T the beginning of 1954 there were many people who expressed doubt as to the future of the requirements of the petroleum equipment industry, but we of the Council felt that, although the major refinery programmes had been completed, there would always be a field for the supply of equipment to take care of expansions and replacements. In my report to the Council for 1953/54, it is evident that contrary to the expectations of many the equipment industry did in fact maintain a very high standard of production and an annual turnover comparable with some of its best years.

The work of the Council itself is growing in scope by virtue of its international work and association with the newly formed European Federation of Equipment Manufacturers. At the same time membership is increasing and active steps are being taken to improve the many services of the Council to its members. We can, therefore, look forward with considerable optimism to the New Year and what it may bring in the way of business. The year 1955 will be marked by the Fourth World Petroleum Congress, which takes place in Rome at the end of May and the beginning of June, and plans



are already far advanced for the part which the Council will play at this congress.

In addition to this the new 'Petroleum Catalogue' will be published in the spring of the year, and the increased scope of this catalogue is concrete evidence of not only the extension of our members' interest in

petroleum equipment, but of their confidence in the future.

It seems logical to us that with the rapid advances which are being made not only in chemistry in general, but also in the specialised development of petro-chemicals as a whole, that the future is a particularly bright one. This does not mean, however, that there is any room for complacency, more especially in the export markets, but with the greater availability of materials it is felt that delivery promises can be kept.

If we can look back at the end of 1955 with the same satisfaction as we can regard the past year, we shall have nothing whatever to complain about.

BRIGADIER C. NORTON STAFFORD, C.B.E., T.D.

(Chairman, British Chemical & Dyestuffs Traders' Association)

IT gives me great pleasure as chairman of the British Chemical & Dyestuffs Traders' Association to extend New Year greetings to all our friends.

As a nation we can derive considerable satisfaction from the knowledge that the task of re-developing our world trade has



been achieved in no small measure. The removal of controls at home, and the reopening of many overseas markets, has been quickly translated by the merchant into trading activity. Prosperity abounds in almost all spheres of and comindustry merce, and in the field of widening

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chemical products, with their new uses and potentialities, the British merchant is making a substantial contribution to our revival as a foremost trading nation.

The old days of *laissez-faire* have given place to a new order in which a healthy rivalry and individual enterprise flourish side by side with that very necessary spirit of co-operation, which finds expression in our representative trade association.

As the consultative body on official matters affecting the interests of chemical merchants the Association fulfils the important function of ensuring that all such matters are approached constructively and with adherence to strict principles. Changing conditions do not come with the leisurely pace of former times, and as new trends of thought take shape we shall be well served by our Association, and we each have a common responsibility to see that its strength is maintained. Therefore, I would remind the chemical merchant that the Association needs his support.

That we have sound foundation for entering the New Year with confidence is no cause for complacency, because we shall meet increasing competition in all markets. Nevertheless, I believe we shall more than hold our own if our endeavours are sustained by the quality of our merchandise and the traditional efficient services of the British merchant. I send my best wishes for the prosperity of all.

LT.-COL. S. J. M. AULD, C.B.E., M.C.

(President, Institute of Petroleum)

THE past year has been outstanding in British petroleum industry even if measured only by the virtual completion of the main plan for extension of oil refining capacity. From 2,500,000 tons in 1944 the throughput has been increased to 29,000,000 tons.

The effect of abundant liquid fuel supplies on the national economy has already been very marked. This is not only in the internal combustion engine field, where the motor car and heavy transport industries have greatly benefited, but in the encouragement of the use of residual fuel oil for power station work. The latter aspect is one of which we shall undoubtedly see more, for the relief thereby accorded to the coal industry, working under its present conditions of relatively lower output, is most important to

the balancing of national power production.

Possibly however it is on the chemical side that petroleum continues to make its importance to national industry most increasingly felt. There are two main approaches to the production of chemicals from petroleum. The first, and the longer established, is the use in synthesis of the simpler unsaturated hydrocarbons, originally available as byproducts of the cracking of oil for increasing the resources of light fuels, but now largely produced deliberately as raw materials.

The second is the more recently established directive hydroforming, so far largely based on platinum catalyst. This process can be used at will for the production of high-octane blending stock, or production of aromatics by conjoint paraffinic cyclisation, naphthenic dehydrogenation and desulphurisation. Benzene, toluene and the xylenes can now be produced in large quantities from petroleum, which is ousting coaltar from its premier position as the source of aromatics. In view of the rapid growth of the plastics and synthetic fibre industries dependent on the aromatics this is of major importance. Four of the 'platformer' units are in process of installation at the great refineries of the United Kingdom.

The United States indicate that over 40 per cent of all their organic synthetic products are already derived from petroleum. Doubtless this figure will be matched here and indeed improved upon.

In view of special British interest in the highly sulphurous Middle East crude oils it is worthy of note that desulphurisation of the important middle distillates using cobalt-molybdenum catalysts has been largely developed in this country.

GEORGE T. GURR, F.R.I.C.

(President, British Association of Chemists)

ONE usually associates New Year Messages with a 'cold and frosty morning'; but I am asked to give this one on a perfect May-like day in early December, which does not help the mood. May we hope that this weather is linked with the international situation and is a good portent for the latter.

It is a pleasant habit to send wishes of happiness and goodwill at this season and I do so to all chemists and their associates at home and abroad for their health and happiness during the coming year.

The year 1954, which started still under

the shadow of threatened industrial regression, has developed into one of increasing and expanding activity in all branches of the chemical industry and production has risen to the credit of all concerned; and this development is naturally reflected in the demands on chemists employed in ancillary laboratories. It is an interesting fact that chemists engaged directly in industry are taking an increasing interest in work study. The demand for chemists has increased during the year as is shown in the weekly list of vacancies given in our appointments circular and is corroborated by the fewer number of claims on our Unemployment Fund. This fund now has reserves of over £56,000, a large portion of which is in a fluid state ready for any emergency which may occur.

Expanding British industry is well served by British chemists whose achievements are a matter of national pride. May 1955 bring prosperity to all readers.

E. P. HUDSON, M.A., F.R.S.E.

(Chairman, Association of Chemical & Allied Employers)

THE past year has not been an easy one in industry generally as far as industrial relations are concerned. In the chemical industry various matters, including an

increase in wage rates about the beginning of the year, were adjusted through wage negotiation machinery of the industry, and thanks to our agreements and good relations with the trade unions we have not been affected by repercussions from industrial difficulties elsewhere. The year



has been one of increased production and productivity, and although the retail price index has shown a measure of welcome stability, organised labour is not unnaturally ever ready to claim some share in the results of any period of prosperity. I believe that the good and reasonable standards set by the Chemical & Allied Industries JIC, the friendly relations with the 'other side,' and the regular advice and assistance which the Association of Chemical & Allied Em-

ployers gives as a service to its member firms, are responsible for the fact that the industry was never freer from industrial disputes.

The majority of employees in the chemical industry are covered by company pension and sick pay schemes. The Association has felt unable to comply with trade union requests that the introduction of such schemes should be formally recommended to its members by the Joint Industrial Council, but at the same time we are satisfied that these benefits are much appreciated by both the men and their unions.

Last year was the first full year of the operation of the JIC training scheme, and in addition to some 140 youths and young adults taking the full course, some 100 older men qualified through the shortened course to gain the status of qualified chemical operator. It has been a matter of satisfaction to us that the general worker unions have been taking an active part, under the auspices of the steering committee, in discussions arising out of the Heavy Chemicals Productivity Team report.

The Executive Board of the Association of Chemical & Allied Employers greatly appreciates the continued support of the members. It believes that as a body of organised employers they not only provide many proper benefits for themselves, but equally benefit the industry as a whole. I am glad therefore to have this opportunity of expressing best wishes for the New Year to the members of the Association and all our friends. May 1955 prove to be a year of steady activity and stability for all in the industry.

MR. A. E. SKAN

(Chairman, British Plastics Federation)

If one can forecast the future by reference to the immediate past, then the plastics industry's prospects for 1955 are of the brightest and its past reputation for instability may be lived down.

In 1953 the total production of plastics materials was double that of 1946, which in turn had doubled the 1942 figures. Although the final figures for 1954 are not yet available these are known to be well up on 1953. Exports for the year are a record for our industry, showing an increase of £1.000.000 for the first ten months as compared with the previous year. Thus has the recession of

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1951 been overcome and this may perhaps be largely attributed to the fact that it is

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becoming widely recognised that plastics are not a substitute but materials in their own right and, as such, it is essential to use the type appropriate to the job.

The British Plastics Federation, in conjunction with the British Standards Institution, are constantly reviewing the

specifications of materials and their particular applications, thus insuring the future against inferior materials and misuse of excellent ones, which can be just as disastrous. Standard specifications issued or in preparation cover a wide range of products from road signs to tableware, protective clothing to flooring and wall tiles. In fact, there is no obvious limit to the opportunities for further expansion.

During 1954 many large new plants came into operation and many more are projected for 1955, their total cost running into millions of pounds and their capacity geared to meet an ever increasing demand.

After many years of 'ups and downs' I feel that the future is at last set fair and in offering my good wishes for a prosperous New Year to those in the plastics and allied industries I do so with every confidence that they will be fulfilled.

N. K. SMITH, B.Sc.

(Chairman, Association of British Insecticide Manufacturers)

THE science of crop protection has made enormous advances in the last 15 years. Up to the outbreak of war, development was on orthodox lines, involving improvements in well-established insecticides and fungicides. From about 1940 onwards came DDT, benzene hexachloride, plant growth-regulating substances and selective herbicides and the organo-phosphorus and systemic insecticides which, in effect, opened entirely new fields of activity. Much of this work owes its basic development to British initiative and research.

The Association of British Insecticide

Manufacturers was founded in 1928, when it became affiliated to the Association of British Chemical Manufacturers. It now represents over 95 per cent of the industry and is concerned with British insecticides, fungicides, weedkillers and allied materials used in the protection of crops of every kind, at home and overseas. Its objects are the development of this section of applied chemistry and biology by meetings and discussions; by the work of its technical committees, by the periodic issue of its Directory and by close co-operation with the Ministry of Agriculture in the standardisation, analy-



sis and approval of insecticides and fungicides. It maintains regular contact with other Ministries and organisations and is represented on many bodies associated with its interests.

The recognition, national and international, of the paramount importance of increasing the world's

food supply and combating the enormous losses caused by pests and diseases, has led to vast expansion in the industry and has stimulated still further the research for new materials and techniques of greater efficiency, economy and safety in application. This expansion is reflected in the increasing work and influence of the Association.

SIR KNOWLES EDGE, Bt.

(Chairman, British Disinfectant Manufacturers' Association)

THE year 1954 has seen continued progress by the British Disinfectant Manufacturers' Association. It is a continued source of satisfaction to the manufacturers of disinfectants and kindred chemicals, that they have for so many years worked together in a strong and harmonious association to deal with those problems which concern the industry as a whole. Disinfectants which at one time were uniformly of a 'coal tar' character are now based upon quite a wide range of chemicals. In addition to the 'black' and 'white' types which have carried the names of British manufacturers to every part of the world, there are now a wide

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variety of substituted phenols, of chlorinecontaining bodies, of a wide range of vegetable bases such as pine oil, and most recently of the quaternary ammonium series,

The British Disinfectant Manufacturers' Association has always taken the foremost part in devising schemes of evaluation for the products of the industry, and since the war has been engaged through a series of technical panels in most exhaustive tests of the present systems of evaluation, as well as detailed work in the development of possible new tests. In my view, during 1955 the countless users of disinfectants will have an ever increasing variety of products offered to them, and it is our hope that the means of evaluation and comparison will keep abreast of this constant development.

D. J. BIRD, M.B.E.

(President, International Superphosphate Manufacturers' Association)

WHEN I was asked to send a New Year's message to readers of THE CHEMICAL AGE I pondered for some time. What could the president of an international manufacturers' association say to industry in this country? I think it was only then that I realised what the founders of the International Superphosphate Manufacturers' Association had achieved. Founded in 1928. the Association now comprises active members from Australia, Belgium, Denmark, Egypt, Eire, Finland, France, Germany, Greece, Holland, India, Israel, Italy, Japan, Mexico, New Zealand, North and South Africa, Norway, Portugal, Spain, Sweden, Switzerland, Turkey and the United Kingdom. In addition, the principal suppliers of raw materials are honorary members.

The Association as such has never entered into any commercial arrangements, and this is probably why it has survived, and almost certainly the main reason for its success. As manufacturers of superphosphate, one of the basic fertilisers so essential for increased food production in all countries, we have an astonishing number of common problems. Through its head office in London the Association collects and publishes trade statistics and, through its Paris office, issues a bulletin in which are summarised, twice a year, agronomic developments affecting the superphosphate industry throughout the world.

The Association holds annual conferences of specialists at which well attended meetings

receive papers of a high standard from many countries. Until this year these specialist conferences have been devoted in alternate years to agricultural subjects and to technical or manufacturing problems. From now on the rotation will occupy three years, with the introduction of a joint conference between agronomists and technicians.

Each year the Association holds an annual convention, visiting different member countries. In 1953 the Association celebrated its silver jubilee in the city of its birth—Stockholm—while in 1954 the meetings were held in Lisbon. This year we are going to Wiesbaden. These meetings provide a unique opportunity for our members to get to know one another.

My New Year's message, and I send it to manufacturers in all countries, is—'Get together with your fellow manufacturers in other countries. You will find you have more in common with them than you think. You will then make, as I am convinced we are making, a practical contribution towards what is uppermost in all our minds at this time, namely, "Peace upon earth and goodwill towards men"."

MR. S. BLACK

(President, Association of Tar Distillers)

I AM honoured to extend New Year greetings on behalf of the Association of Tar Distillers to all friends and readers of The CHEMICAL AGE.

The last year has been a fairly successful one despite some fluctuation in the markets for certain products. The actual quantity of crude coal tar distilled is not known at



the time of writing but it will approximate 2,800,000 tons, which represents an increase of over 50 per cent on the immediate pre-war tonnage. Sales of tar products in the home markets have increased during the year and exports have been reasonably main-

tained—having regard to the increasing com-

Co-operation between the tar industry and the chemical industry and allied trades has continued to the advantage of all concerned and a growing understanding of each other's requirements and interests augurs well for the future.

Energetic research is being carried out by the Coal Tar Research Association in their laboratories at Gomersal, and members are most appreciative of the assistance and advice which they have received on particular problems which arise from time to time.

With regard to the future, it is likely that the implementation of the Beaver Committee Report will result in an increased carbonisation of coal with a corresponding increase in the production of crude coal tar. The tar distillers are exploring the present and possible future markets for tar products with a view to providing a balanced programme of production and disposal of the various products to meet the requirements of the consumers and users and secure a reasonable return to the carbonising industries for the crude coal tar.

It is the desire and aim of the tar distilling industry to develop closer co-operation with kindred industries and maintain a high standard of service which will give satisfaction to the buyers of their many products and to the suppliers of the crude tar. I have pleasure in extending sincere greetings to all and best wishes for a successful and prosperous year.

MR. R. ASHLEY HALL

(Late president, National Federation of Associated Paint, Colour & Varnish Manufacturers of the UK)

THE office of president of the National Paint Federation, which I have recently relinquished, enables one to enjoy a bird's eye view of the complexities and varying circumstances of the trades of manufacturing, distributing and applying paint.

While the more essential raw materials and basic principles of manufacture may be common to all producers, there is an immense variety as to the end use for which paint is required, with a consequent variety in both the qualities and characteristics necessary and the customs and practices of distribution and marketing generally.

All such ramifications, their particular individual problems, their general requirements, the place they hold in the national economy, the assurance of raw material supplies, often necessitating negotiation for their

importation from hard currency sources, the relationship between one outlet and another, and ensuring there is a tidy and responsible marketing practice in each, come within the influence of the National Paint Federation.

I can say, with confidence, that prospects for 1955 augur well. Shipyards appear full of work, the demand for consumer goods booms, more houses are being built and there is a general uplift in the standard of living that itself demands better conditions and more colour in our homes, hotels, offices, schools and factories. Behind us all, whether manufacturer, distributor, or applicator, are wise and well staffed, experienced, trade organisations.

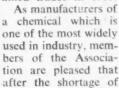
So, with a progressively increasing demand before us, in all the various outlets and uses for paint, and a wise influence behind it, coming from the National Paint Federation and other appropriate trade organisation. I feel my good wishes for prosperity and progress in 1955 age well based on solid facts rather than on sentiment alone.

MR. R. E. HUFFAM

(Chairman, UK Glycerine Producers' Association)

A S chairman of the United Kingdom Glycerine Producers' Association Ltd., it gives me pleasure to respond to the invita-

tion of the Editor of THE CHEMICAL AGE by sending a message of good wishes for the continued success of the chemical and allied trades in 1955.



the past years, glycerine producers have now increased glycerine supplies to the extent that, recently, buyers have obtained nearly all their full requirements without delay and at reduced prices.

Despite the increase in demand for glycerine which is expected to take place in 1955, the Association is hopeful of satisfying buyers' wishes, as world supplies should be maintained because of the anticipated



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larger production of American synthetic glycerine.

We wish all our friends in the trade a prosperous 1955, and would assure them that whatever may lie ahead, it is the aim of Association members to give the best possible service to industry.

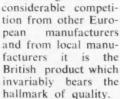
MR. J. N. HOPE

(Chairman, Association of British Sheep & Cattle Dip Manufacturers)

AM very grateful for the opportunity of wishing all readers throughout the world success and prosperity in the coming year, in which all members of the Association join me.

The manufacture of sheep and cattle dips is a highly specialised branch of the chemical industry and we are proud to number among our members firms who have pioneesed throughout the world this important contribution to animal husbandry.

Considerable quantities of sheep dip are used in the United Kingdom but the main bulk of our members' production is shipped overseas. Our industry, therefore, can be said to be an important contributor to Britain's export trade. Although there is



The Association, which is affiliated to the Association of British Chemical Manufacturers, is entirely voluntary and

was formed in order that member firms should have an instrument enabling them to approach Government organisations and other official bodies on a joint basis on questions of mutual interest. The smooth working of this co-operation was largely responsible for the maintenance of the industry in the difficulties of wartime. In the post-war period the Association has been no less active in serving its members.

To-day, questions of actual interest to the industry and Government concerns both here and abroad are freely discussed and

official and commercial organisations seeking advice on technical questions can consult members through the Association. The free exchange of opinions on matters both commercial and technical among our various members has been a remarkable illustration of the sense of fair play and patriotism which exists in British industry today. The existence of the Association, whose members compete against each other in a highly competitive market, has been an additional assurance to the users of our products that the high standard of quality of British products is maintained.

With the ever increasing demand for the products of members and with the increasing complexity of the technical problems which have to be confronted, we of the Association are convinced that we can continue to play an increasingly valuable part in the British chemical industry.

MR. STANLEY ROBINSON

(President, British Wood Preserving Association)

FOLLOWING a quiescent period during the war and immediate post-war years. the Association was reorganised in 1949 and although it has not yet proved possible to introduce all the plans envisaged at that date, it is pleasing to record that very real progress has been made. There are now 341 members in the Association, including almost every firm in Great Britain possessing a plant for pressure impregnation, most of the well-known manufacturers of preservatives, insecticides, fungicides and fire retardants, many allied trade associations, learned societies and timber users at home and over-Liaison has been established and maintained with such bodies as the Forest Products Research Laboratory, the British Standards Institution, Government departments and the Timber Development Associa-

At the 1954 Convention held at Cambridge there were 250 delegates, including representatives from many Government departments, user industries and 11 overseas countries. Among the papers presented were two of particular interest from the United States, one dealing with solvent type preservatives, the other with the development of a new solvent extraction method for characterising coal tar creosotes and petro-

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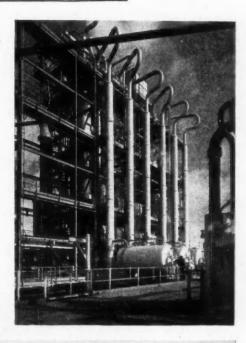
N ving leum derivatives and its application in wood preservation. In 1954 the Association had outside stands at both the Royal Show and the Great Yorkshire Show, being awarded the Silver Medal Certificate at the latter and the Bronze Medal Certificate at the former.

A number of lectures on 'Preservation' were given during the year, the total being well over 60, including several for the Ministry of Works. Great use has been made of the Association's advisory service. An example of this is to be found in the fact that in the last six months, in response to requests, 5.000 copies of the Association's

leastet dealing with the common furniture beetle have been distributed.

During the year, close liaison was maintained with the British Standards Institution in the revision of BS.144 'Creosote' and BS.913 'Pressure Creosoting of Timber.' The Association also completed the preparation of comprehensive specifications for waterborne preservatives applied by pressure in this country and it is hoped that these will be published in a BWPA Manual in the near future, when the evidence of satisfactory service in use submitted by the manufacturers has been examined.

The distillation unit, heart of the silicones plant of Midland Silicones Ltd. at Barry. The plant, which cost £1,500,000, was designed for a throughput of 600 tons per year, and at capacity should be supplying 95 per cent of the company's sales



The recently completed works of Stockdale Engineering Ltd. at Poynton. It has now been decided to extend the floor area by some 80 per cent of the present amount



US Chemical Exports

Decline in Importance Foreseen

A FORECAST that the US chemical industry's export trade would continue to decline in relative importance was made by Dr. Lewis E. Lloyd, assistant to the treasurer, The Dow Chemical Company, when he spoke at the fourth semi-annual meeting and winter conference of the Manufacturing Chemists' Association in New York recently.

'The record of United States foreign trade shows that while it has been increasing dollar-wise, it has been progressively decreasing in importance percentage-wise,' he said. The reason was that with industrialisation came rapid technological advance and domestic commerce grew much more rapidly than foreign commerce, with the need for imports and exports decreasing. The trade need of the US was for imports of basic raw materials and commodities and exports of finished goods to pay for them. Any trade beyond this was superfluous, and increased markets should come from an expanding and dependable American mass market.

'In the past five years, organic chemical imports have increased rapidly while exports have actually decreased slightly,' Dr. Lewis went on. 'The 1953 exports of organic chemicals were less than in any other year since 1946. On the other hand, imports have increased by more than 500 per cent just since 1948. All of the industrialised nations have increased chemical shipments to the United States, but the United Kingdom and Germany have made the most substantial in-

creases. Germany is the second largest foreign supplier of organic chemicals. Only Canada with its many US subsidiaries and its geographic closeness ships more to us.

'The data indicates that the foreign market for our organic chemicals is not expanding and only expanding slightly for total chemicals. As we look into the future, we can expect the trends to continue on exports and imports—that is, imports to continue to rise and exports to decrease perhaps at a faster rate.'

During and immediately after the war, Dr. Lewis pointed out, the US was called on to supply the former customers of European countries, but within the last two years poswar reconstruction in Europe had largely been completed. The chemical capacity had increased in foreign countries beyond their domestic needs and the excess was exported.

Foreign producers have made a special effort in many cases to export to the United States to get dollars, but they are also regaining their pre-war customers throughout the world,' he went on, 'Because of the low cost of production due to wage rates onefifth to one-fourth that of ours, our foreign competitors have been and probably will continue to undersell us in world markets. As a consequence, it would not be surprising if our exports of chemicals decreased still further. Moreover, even at present tariff levels we can expect increased competition from chemical imports. The key here will largely be the speed with which foreign producers expand their capacity. They are now operating substantially at capacity, and will have to expand to get more of the market.



A view of part of the main laboratory block and the office wing of the research building of I.C.I. Plastics Division, opened on 5 January last year. It is constructed on revolutionary principles, all interior appointments being movable

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Europe's Chemical Industries Expand

OEEC Report Urges Freer Trade

IN its report on The Chemical Industry in Europe, the OEEC Chemical Products Committee finds that, taking member countries as a unit, production in the chemical industry increased between 1951 and 1953 far more than the average for European industry as a whole. Progress was particularly marked in Italy (57 per cent increase), Germany (43 per cent), Belgium (22 per cent) and the UK (20 per cent).

The committee points out, however, that this trend must be seen in the light of the world situation which has changed considerably since before the war. At that time production in the OEEC countries represented about 50 per cent of world production; in 1951 it was about 25 per cent, while United States production, which before the war was about 30 per cent of the total, rose to over 40 per cent.

The chemical industry, says the report, is a complex of industries rather than a single industry, and the chemical field is one where it is particularly difficult to obtain adequate and comparable statistics. Moreover, development was not uniform in the various sectors. For example, the output of basic and intermediate products and of certain end-products, such as plastics and synthetic detergents, expanded considerably, whereas for other products it remained stationary or even declined, as in the soap industry.

Wide Market Needed

Normally a large-scale producer, the chemical industry requires a wide market. The European industry has to face increasing competition both at home and abroad from the American industry, which has the advantage of a big domestic market. This is sufficient indication of the need for a free flow of trade among OEEC countries.

Trade between OEEC countries, including their overseas territories, could no doubt be further increased if present obstacles were relaxed, says the report. In the main, there are two such obstacles: quantitative restrictions and customs duties. The committee has been studying the first for some time and has made recommendations for the further freeing of trade in this sector. A study undertaken at the end of 1953 showed that

in 1952 rather more than 75 per cent of trade in chemicals was liberalised. Since then additions have been made to the free list so that the trade in chemicals now subject to quantitative restrictions may amount to only 20 per cent of the total trade in 1952. The committee has undertaken no definite study of customs duties but has from time to time drawn attention in its reports to the various tariff levels in different sectors.

A more detailed examination of the question of freer trade between European countries is given towards the end of this article.

Optimism Justified

The committee considers that in general prospects in most sectors of the chemical industry justify a certain degree of optimism for the future. The present economic situation, which shows a high activity in most sectors to which the chemical industry is a supplier, implies high activity in the production of chemicals as well. In the long run, the expanding use of chemical products would seem to leave much scope for further development in this industry.

Supplies of raw materials, previously often difficult and in short supply, became regular in 1953. Fats and native sulphur are once more available in adequate quantities, as are certain intermediate products, e.g. phthalic anhydride, cresylic products, titanium dioxide, etc. A problem arises for Italian sulphur, production of which has increased as a result of the shortage of American sulphur and which has difficulty in competing with the latter owing to high production costs.

In the basic sectors—organic and inorganic chemistry—of which a dozen representative products are reviewed in the report, the increase in production shows considerable differences as between the various products. Speaking generally, it appears that substantial progress has occurred in the organic chemical sector, especially as regards acetone, which is used as a solvent, the manufacture of plastics, films, etc., and phenol which is used in the pharmaceutical industry and for synthetic aromatics, synthetic tannins, resin, etc.

In inorganic chemistry the greatest increase is found in the production of chlorine (and

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consequently, though to a less extent, of caustic soda) and synthetic ammonia. The fertiliser industry, which is steadily expanding, is the largest consumer of ammonia. Chlorine is used in ever increasing quantities for the manufacture of plastics (PVC), insecticides, weedkillers and solvents.

More Petrochemicals

The petroleum chemical industry is assuming greater and greater importance as a source of basic chemicals for the manufacture of new products such as plastics, synthetic detergents, etc. Following the spectacular development of this industry in the United States during and since the war, five European countries-France, Italy, the Netherlands, the United Kingdom -now have extensive petroleum plants. They will soon be joined by Belgium. Investment from \$240,000,000 in 1953 to \$260,000,000 in 1954, an increase of about 8 per cent. It is expected to go up by about 80 per cent by 1957.

Considerable progress is recorded in the plastics and fertiliser sectors. The latter will be reviewed in a special report to be issued shortly by the OEEC Chemical Products Committee.

If the experts' estimates prove correct, the dyestuffs industry will be found to have regained its pre-war production level in 1954. It should be noted, however, that the output of OEEC member countries, which was 50 per cent of world production in 1937, has fallen to 37 per cent.

The soaps and detergents sector shows two contrary developments. While consumption of synthetic detergents is increasing rapidly and replacing, in particular, certain types of household soap, the soap industry is being deprived of some of its traditional customers.

Throughout the chemical industry the post-war situation was characterised by unsatisfied demand and therefore by high prices, which in most cases stimulated production. However, during the last 18 months prices have in general fallen while production has continued to expand.

Plant, particularly for the production of basic chemicals, demands high capital outlay, often difficult to procure in the post-war years. Accordingly, the industry was often compelled to finance the necessary investment by drawing on its own resources; this was facilitated by the high prices prevailing at the time. Since then, the situation has

changed and the chemical industry has made more and more use of other methods of financing, in particular the capital market. In some cases where the investment costs were heavy, two or more companies fell back on the method of joining in financing a project.

International trade in chemical proproducts amounted in 1953 to \$2,000,000,000 for exports and \$1,200,000,000 for imports; OEEC countries are therefore net exporters of these products and their shipments of them represent 7 per cent of total European exports. A fact worthy of note is that these countries, whose dollar imports of chemical products exceeded their dollar exports by 14 per cent in 1941, exported to the dollar area 28 per cent more than they imported from it in 1953.

Trade between OEEC countries accounted for slightly over 40 per cent of their exports of chemical products. Trade with the overseas territories is relatively insignificant in the case of imports, but represents 14 per cent of member countries' total exports. As regards trade with the rest of the world, in 1953 about two-thirds of imports came from the dollar area and one-third from other countries; while slightly over one-quarter of European exports went to the dollar area and about three-quarters to other countries.

Italy's Progress

The report contains a brief survey of trends in the chemical industries of each of the 18 OEEC countries (the figure includes Trieste). The striking growth of the chemical industry in Italy has taken place in spite of a high degree of liberalisation of trade in chemical products. The present level of production is well over 100 per cent above the 1938 level. Production was almost stagnant from 1951 to 1952 at about one-third above the 1950 level. A new peak was reached in 1953 when production reached a level more than 50 per cent above 1950. By the end of 1953 and at the beginning of 1954 chemical production was between % and 80 per cent above 1950.

The increase is due in particular to developments in plastics, detergents and nitrogenous fertilisers and progress is being helped by the development of natural gas and the growth of the petrochemical industry.

In West Germany the chemical industry did not revive quickly after the war, and

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production in 1950 did not reach its prewar level. Since then, however, there has been an uninterrupted rise in production, although it was insignificant from 1951 to 1952. There was a considerable increase during 1953, and the level reached at the beginning of 1954 was well over 50 per cent above that of 1950.

Chemical production rose in Belgium after the war, but there were depressions in 1950 and 1952, the second one only ending in the last months of 1953. Since then there has been an improvement which has not, however, been accompanied by an increase in profit margins, since prices are still very low. Two factors limiting Belgian output are the maintenance of import restrictions in countries which traditionally import from Belgium and fierce competition from imports, since 88 per cent of Belgian imports are liberalised and customs duties are generally low.

For the British chemical industry 1953 was a successful year. Production again expanded considerably after the levelling-off which had followed the post-Korean rise. Compared with total industrial production, production of the chemical industries increased at a much higher rate than total industrial production. The rise which, except for the interruption in 1952, has now been continuous for many years, was the result of a large investment programme. On the other hand, total exports of chemical products from the UK declined steadily in value between 1951 and 1953.

Rises in Other Countries

The situation in France is not unlike that in Britain. The 1952 recession came to an end in March 1953, and since then there has been a steady rise in production which in 1953 was 14 per cent above the 1950 level.

Fairly substantial increases in output also took place in Norway and, possibly, Switzerland, but statistical information about the latter is incomplete.

In an appendix to the report, the question of the liberalisation of trade is discussed in some detail. On the whole, the percentage of chemical products that can be freely imported into member countries is high, particularly in Switzerland, Italy, Portugal and Sweden. Three countries—France, Iceland and Turkey—are substantially behind the others, Iceland and Turkey allowing no chemical products to be imported freely. The

United Kingdom stands about halfway down the list, 82 per cent of chemical imports being freed.

Grave difficulties have been encountered by the chemical industry in a number of countries with a high liberalisation percentage. These can be summarised under five main heads: the somewhat unsatisfactory state of liberalisation still prevailing in a few countries; the comparatively low level of liberalisation in certain groups of chemical products; the extended of administrative measures which partially limit or neutralise the officially announced liberalisation percentage or which artificially stimulate exports; recourse to unorthodox methods by certain exporters; and the effect of high customs duties.

These facts were studied late in 1953, since when Austria, France and Germany have freed additional products, but the general conclusions, it is stated, still hold good.

The report, published by the Organisation for European Economic Co-operation in Paris, is obtainable in this country through HM Stationery Office at a cost of 9s.

Course at Norwood

BEGINNING on 15 January, a course of twelve lectures and appropriate practical work on micro and semi-micro techniques in chemistry will be held at Norwood Technical College, Knights Hill, London S.E.27, on Saturday mornings from 9.15 a.m. to 12.30 p.m. Lectures, illustrated by demonstrations, will deal with organic preparative techniques and qualitative analysis, the design and construction of apparatus, and simple chemical microscopy.

In the main, apparatus either easily constructed or normally at hand will be used, as the course is of an essentially practical nature. The fee for the course is £1 2s. 6d. Application for admission should be made to the Secretary of the College.

Record Oil Output Expected

A record world output figure of over 700,000,000 metric tons is expected to be reached by the oil industry for 1954. The figure for 1953 was 678,000,000 metric tons, and the increase is due mainly to the high rate of production in the Middle East.

New Year Honours

Awards to Chairmen of Two Oil Companies

CREATED a baron in the New Year Honours List, Professor Edgar Douglas Adrian, O.M., M.D., M.A., Hon. D.Sc., Hon. LL.D., F.R.S., F.R.C.P., is president of both the British Association and the Royal Society. Now Master of Trinity College, Cambridge, he has had a distinguished academic career.

SIR WILLIAM FRASER, Kt., C.B.E., LL.D., Officer of the Legion of Honour, who is chairman of the British Petroleum Co. Ltd. (formerly Anglo-Iranian Oil Co. Ltd.) has also been made a baron. Hon. Petroleum Adviser to the War Office since 1935, Sir William was awarded the Cadman Memorial Medal of the Institute of Petroleum in 1946.

Among the new Knights Bachelor is Mr. LEONARD SINCLAIR, chairman and managing director of another oil company, Esso Petroleum Co. Ltd.

The Order of the Bath is awarded to SIR JOHN PRIMATT REDCLIFFE MAUD, K.C.B., C.B.E., Permanent Secretary, Ministry of Fuel and Power (G.C.B.), and GEORGE ROBERT DISRAELI HOGG, C.B.E., Under-Secretary and Establishment Officer, Department of Scientific and Industrial Research (C.B.).

Other awards include the following:

Order of St. Michael and St. George C.M.G.

EDWARD WALTERS SENIOR, Commercial Director, British Iron and Steel Federation.

Order of the British Empire K.B.E.

OWEN HADDON WANSBROUGH-JONES, C.B., O.B.E., Chief Scientist, Ministry of Supply.

C.B.E.

CHARLES SIDNEY BRYANT, lately Director of Materials and Explosives, Research and Development, Ministry of Supply; MAURICE WALTER GOLDBLATT, M.D., Director Industrial Hygiene Research, Imperial Chemical Industries Ltd.; HAROLD WILLIAM HOBBS; Director of Ordnance Factories, Mottingham, Ministry of Supply; HORACE ERNEST JACKSON, lately President, British Non-Ferrous Metals Federation; MICHAEL JAMES

CONDON, managing director, Burmah Oil Company, Karachi, Pakistan; WILLIAM SIN-CLAIR, director of the Dunlop Rubber (Scotland) Co. Ltd., for political and public services in Glasgow.

O.B.E.

GEORGE DOUGLAS ELLIOTT, works manager (iron), Appleby-Frodingham branch, United Steel Companies Ltd., Sheffield, WYNN HAVRYN EVANS, Principal Scientific Officer, Safety in Mines Research Establishment, Ministry of Fuel and Power; WILLIAM JOHN FELTON, secretary, Institution of Mining and Metallurgy; FRANCIS WILLIAM TOOVEY, Director, West African Institute for Palm Oil Research.

M.B.E.

THOMAS WILLIAM GREAVES, Safety Officer, Dunlop Rubber Co. Etd., Birmingham; ARTHUR EDWIN HILL, manager, glass works. British Thomson-Houston Co. Ltd., Chesterfield; Frank Marriott, works manager, Head Wrightson Steel Foundry Ltd., Stockton-on-Tees; Charles Bruce Piblado Morton, D.S.O., D.F.C., assistant to the chairman, Matthew Hall & Co. Ltd.; WILLIAM EDWARD SHAW, deputy works manager, Charlton factory, United Glass Bottle Manufacturers Ltd., London; Frank Edward Smith, member of the scientific staff, Medical Research Council.

British Empire Medal

JOHN EDWIN DAVIES, oil mill foreman, J. Bibby & Sons Ltd., Liverpool; EDWARD ROOKE, works technical officer (Grade III). Fuel Research Station, DSIR; JOHN MITCHELL WOODGATE, laboratory worker 'A.' United Kingdom Atomic Energy Authority. Sevenoaks. Kent.

Obituary

PROFESSOR HENRY TERREY, B.Sc., died suddenly at Blackheath on 24 December, aged 65. He had been at University College since 1921, was appointed professor of chemistry in 1952, and retired in September last year.

Plastics in Effluent Treatment

Some Effective Installations

THERE is an increasing demand by local authorities and others for the reduction of atmospheric pollution and corrosive components of factory effluent, and this is bringing forward the services of specialists in this field of corrosion resistance.

Corrosion-resisting plastic materials, such as rigid PVC and polythene, are widely used in the fabrication of ducting, etc., for the conveying of corrosive fumes. The use of these materials has more recently been extended to the fabrication of scrubbers used for the washing and neutralisation of these fumes. Such plants have recently been installed by Acalor (1948) Ltd., Crawley, Sussex, at various metallurgical factories for the disposal of large volumes at high concentration of acidic fumes.

In the construction of such plant, PVC-fabricated ducting is used for the collection of the corrosive fumes. These are passed to a scrubbing unit fabricated entirely in rigid PVC wherein the fumes are drawn up a side flue, through a dome, where the spraying tubes are situated, and then down (with reduced velocity) through curtains of falling soda solution. The scrubbing liquid is pumped to the spray units and drains back from the bottom of the PVC scrubber into a large sump, itself plastic-lined against corrosion.

The scrubbed fumes, by now free from acid and quite neutral, are drawn off through a large PVC duct to a rubber-lined paddle

type centrifugal fan and thence to a chimney.

In many cases, pH measurement have shown that the gases and vapours exhausted from the chimney are completely neutral and all that is necessary in maintaining the plant is for occasional checks to be made on the alkalinity of the soda solution in the main sump. Facilities are provided for the occasional rapid discharging to drain of the neutralised soda solution.

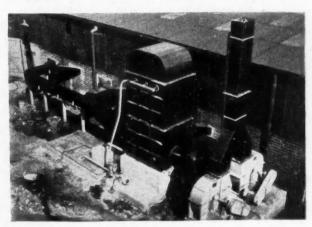
It is likely that this type of equipment, owing to the nature of the materials used in its construction, will give many years of satisfactory service and it is said that atmospheric conditions have certainly improved in the vicinity of the installations.

For some time, firms specialising in the treatment of trade effluent have used brick linings for treatment and settling chambers, and more recently acid-resisting cement renders for settling chambers.

There are, however, numerous firms with only relatively small quantities of effluent needing treatment (e.g., 300 gph.) and in these cases the Acalor system can be recommended. Instead of concrete shells lined with brick and acid-resisting cements, mild steel composite tanks with welded-in baffle walls, weirs, etc., are lined throughout in Acalastic PBY (acid and alkali-resisting plastic sheet). These units can be dropped into a pit or used at ground level, depending on the drainage levels concerned.

Circular dosing tanks-fitted with hopper

Courtesy Henry Wiggin & Co., Ltd.



A fume scrubbing plant installed by Acalor

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died mber, ollege hemfeeds and electrical agitators are mounted over the treatment compartments and these provide controlled dosing of the neutralising liquors, lime slurry, ferrous sulphate solution, etc. The position of baffle walls and weirs is determined by the rate of flow of the effluent and the mixing times required.

There appears to be a general demand by firms having a small-scale effluent problem which can be well catered for by the installation of such a compact and even portable system.

Keeping Warm

Low Temperature Heating Equipment

DESIGNED to overcome the difficulty of storing chemicals and oils which crystallise or solidify readily, the Warm Shelf is being produced by Mc. & B. Heat Control Ltd., of Heaton Works, Potter Street, near Harlow, Essex. The temperature is so low that it may be left on day and night without overheating, and the shelf will run continuously for about 40 hours on one unit of electricity. It is said to have no adverse effect on the contents of the bottles and there will be no fear of the glass cracking. It is 18 in. by 8 in. in size, larger models being to order.

The firm also produce a Warm Ointment Slab, surmounted by a plate of $\frac{1}{4}$ in. plate glass which can be removed for cleaning purposes. When warm, after about 20 min., the temperature of the slab is such that ointment will become easily workable in a few moments, even in the coldest weather. The slab is 1 ft. by 1 ft. by $\frac{1}{2}$ in. thick.

Another low temperature product is the Warm Assembly Panel which is intended to produce sufficient warmth to keep the hands and fingers of operatives engaged in small assembly work comfortable during cold weather. The panel can be run for a working week at a cost of a penny and, it is claimed, increased production can pay for the initial outlay in a matter of days, under certain circumstances.

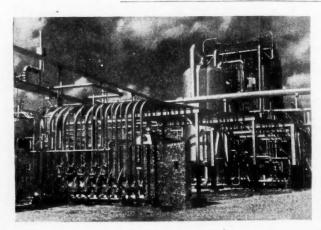
The Warm Duckboard is constructed with a hardwood frame and is faced with a resin bonded hardboard. It comes in standard sections of 3 ft. by 18 in. which can be used as individual boards or butted together. The loading is such that it 'produces complete comfort for the feet and allows a gentle warmth to rise round the body.' One section will run for more than six hours on a unit of electricity.

It can be used on concrete floors for machine operatives, etc.

Presentation to Founder

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To celebrate the 40th anniversary of the founding of the company and thereby the start of the volumetric glassware industry in Britain, the directors and employees of H. J. Elliott Ltd., Treforest, Glam., made presentations to their founder director, Mr. H. J. Elliott, at the works annual Christmas Eve dinner. The presentation on behalf of the employees was made by Mr. G. C. Devereux, manager of the Technical and Development Division, who joined the company in 1918. Mr. G. D. Shepherd, M.B.E., J.P., F.C.A., made a presentation on behalf of the directors.



The propane dewaxing unit of the lubricating oil plant at Esso Refinery, Fawley, which was completed last year

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Recent Advances in Gas Absorption, Cooling & Humidification

by J. W. MULLIN, B.Sc., A.R.I.C.

(Department of Chemical Engineering, University College, London)

AS absorption practice has advanced Considerably since its humble, but romantic, beginning around 1836 when William Gossage is reputed to have filled a derelict stone windmill with brushwood to scrub hydrochloric acid fumes from the gases emitted from his soda factory in Worcestershire. Research and developments in gas absorption and allied subjects form a considerable contribution to the present-day technical literature, and this past year was no exception. In addition to the normal volume of technical data, a symposium on gas absorption was held by the Institution of Chemical Engineers at Birmingham in April at which some 20 papers were presented. The following review attempts to correlate some of the progress made in 1954.

Theoretical Aspects

A neat review of the fundamentals of diffusional operations is presented by Pigford¹ in the form of a 'refresher' course. Morris and Jackson in their recent book² also give concise theoretical treatments sufficient for the understanding and design of absorption and stripping towers. The concept of the additivity of the resistances to mass transfer between phases has long been used in the theoretical and practical analyses of diffusional data, and this is usually expressed by the equations

$$\frac{1}{K_{G}} = \frac{1}{k_{F}} + \frac{1}{Hk_{1}}$$

$$d \frac{1}{K_{F}} = \frac{1}{k_{F}} + \frac{H}{k_{F}}$$

where K_G and K_L are the overall coefficients on the gas and liquid phase bases respectively, and k_π and k_1 are the respective film coefficients. H is usually referred to as the solubility coefficient (ratio of the change in concentration of dissolved gas to the change in partial pressure). If Henry's Law holds, then H will be a constant at constant temperature.

An experimental investigation of the applicability of this additivity of resistances

has been carried out by Goodgame and Sherwood³ who studied the vaporisation of water into air and the absorption from air of CO₂, ammonia and acetone by water. The results showed that the concept is justified. Fujita et al.⁴ studied the absorption of CO₂ by caustic soda solutions in packed columns. Using experimental values of K_Ga (a = surface area of packing per unit volume of tower), they calculated values of k_ga and k₁a in physical absorption from the equation

$$K_{Ga} = K_{ga} + \beta H k_{1}a$$

Experimental values of β showed good agreement with theoretically derived ones.

The kinetics of liquid-film processes in gas absorption have been treated theoretically and investigated experimentally by Dankwerts and Kennedy³. Whitman's two-film theory and Higbie's theory of systematic surface renewal are discussed, and a theory based on the random renewal of the surface is proposed by the authors. The liquid-film transfer coefficient for physical absorption can be expressed by the equations

$$k_1 \propto \frac{D}{x}$$
 (Whitman)
$$k_1 \propto \sqrt{\frac{D}{\pi t}}$$
 (Higbie)
$$k_1 \propto \sqrt{D.s}$$
 (Dankwerts)

where **D** is the diffusivity, **x** is the effective liquid film thickness, **t** is the time of exposure of the liquid surface and **s** is the fractional rate of surface renewal.

These three methods are found to lead to similar predictions of the effect of chemical reaction and other physico-chemical factors on the rates of absorption. Although Whitman's theory gives an easily understood pictorial representation of the mass transfer process, the other two theories do not require explicit values of any of the physico-chemical quantities involved or even the order of the chemical reactions which may take place;

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they only require a measurement of the transient rates of absorption for short contact times between gas and liquid. Such rates were measured by a rotating drum method using CO₂ and water, solutions of salts, buffer solutions and caustic soda solution with exposure times less than ½ sec. Evidence of a considerable surface resistance to CO₂ absorption in water was noted. The comparison of experimental and theoretical data suggests that none of the theories can be considered satisfactory, but the use of the concept of a random surface renewal seems to be a better approach to these problems.

Fundamental Research

Research of a fundamental nature has been reported by Edwards et al.6 on mass transfer phenomena in short liquid jets using the absorption of CO₂ in ammoniacal solu-Under these conditions the absorption followed certain theoretical mechanisms. and empirical equations for absorption rates are given. It was concluded that conditions in the liquid film control the rate of absorption and that the gas film conditions are unimportant. The controlling factor was suggested to be the slow reaction of CO2 (in solution) with NH₃ (in solution), coupled with the slow migration of dissolved CO2 away from the surface zone. Surface tension depressions produced by the introduction of wetting agents had no influence on the rate of absorption, and it was suggested that the reason why other workers have found that it does have an effect is probably due to an increase in the effective wetted area of the packings used.

Current theories on mass transfer through liquid films are reviewed by Emmert and Pigford⁷ and they studied the interfacial resistance to gas absorption in a 3.7 ft. wetted wall column. Work was carried out on the absorption and desorption of O₂ and CO₂ in water. When the water contained a wetting agent, ripples were suppressed and mass transfer was reduced by over 50 per cent. These data agreed with those obtained in a 1½ in. long tube which was so short that ripples had no time to form. Transition from laminar to turbulent flow occurred at a Reynolds number of about 1200.

The effect of the liquid rate L on the liquid film transfer coefficient k_1 was determined by Ueyama *et al.*⁸ using the absorption of CO_2 by water in a 2 in. dia. column packed with small glass rings. They found that $k_1 \subset L^{0.54}$ for liquid rates 250 to 6,000 kg.

per sq. m. per hr. and that for liquid rates 6,000 to 60,000 kg. per sq. m. per hr. the exponent of L rose to 0.77.

The effect of liquid concentration on the liquid-film transfer coefficient has been expressed in an empirical equation by Tierney et al." To obtain the true value of ka under operating conditions, the value of ka is determined for a dilute solution at the desired liquid and gas rates and then corrected for concentration by a rather complicated equation.

The effect of pressure on the gas-film absorption coefficient in packed towers has been studied by Zabban and Dodge¹⁰, who used two towers, 6 in, and 12 in, dia., with various packings. Acetone/air methanol/air mixtures were used countercurrent to water and pressures ranged from 1 to 14 atmospheres. The water rate was kept constant at 2,900 lb. per hr. per sq. ft. and gas rates from 200 to 1,200 lb. per hr. per sq. ft. were employed in the 6 in. column. In the 12 in, column, the water rate was kept at 4,500 lb. per hr. per sq. ft. and gas rates varied from 200 to 600 lb. per hr. per sq. ft. Gas-film and liquid-film coefficients are recorded.

Wetted Wall Columns

Data on heat and mass transfer at high humidities in wetted wall columns are given by Cairns and Roper11. The column was with operated adiabatically current air and water. The liquid rate was found to have an appreciable effect on the transfer coefficients, and it was shown that the well-known equations of Gilliland and Sherwood and of Chilton and Colburn are not applicable under these conditions. The operation of wetted wall columns is also discussed by Morris and Jackson² and the use of this apparatus for the study of gas-film controlled processes is described.

A new approach to the mechanism of mass transfer in the gas phase is presented by Bakowski¹². He considers that mass transfer depends entirely on the velocity of the molecules, their concentration at the interface and the gas stream velocity. An equation is derived, based on this hypothetical mechanism, where the mass transfer coefficient is given by

$$K_G = \frac{1.0 \times 10^{-6} (v + 60)}{M^{1} R^{1}}$$

where v is the gas velocity (cm. per sec.), P is the total pressure (atmos. absolute) and

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M is the molecular weight of the gas. For gas mixtures, M is arbitrarily taken to be the geometrical mean of the molecular weights of the components $(M = \bigvee M_1M_2)$. Large quantities of published data are compared with this equation and the agreement is good. While the derivation of the equation is open to critcism, its use should find considerable support for practical design purposes.

The use of liquid films in the study of gas absorption by droplets has been presented by Dixon and Swallow¹³ who tried to find a physical barrier capable of separating two gas phases while permitting the passage of drops. Neither a draught of inert gas moving across the base of the absorption chamber nor a mass of foam closing the base were completely successful, but various liquid films stretching across the top or base of the chamber provided a gas barrier with a life of several hours.

Passage of drops through the film was observed by high-speed photography. The desorption of CO₂ by water drops in air was measured and the results compared well with theoretical equations. The degree of turbulence was found to have the same effect in desorption as in absorption.

Garner and Hammerton^{14,15} studied the rate of solution of gas bubbles in liquids; a number of gases were used in water and glycerol. Bubbles less than 0.2 cm. dia. act as rigid spheres, but at 0.4 cm. dia. a vigorous toroidal circulation sets in; this affects the mass transfer considerably. Diffusion in the two liquids used was governed

by the equation $Nu = constant.Re.Sc^{0.33}$

where Nu, Re and Sc are the Nusselt, Reynolds and Schmidt numbers respectively. The value of the constant is 0.11 for water and 60 for glycerol. Traces of surface active materials cause the surface of the bubbles to become rigid and the rate of solution is reduced.

Carbon Dioxide Absorption

The absorption of CO₂ in various solvents has been a popular subject in published papers during this past year. From the academic point of view, CO₂ is readily available in the pure state and, being relatively insoluble in water, it provides an ideal system for studying liquid-film characteristics. A number of papers on this subject have already been discussed above. From the industrial point of view, CO₂ is often a detri-

mental substance in various gases and its efficient removal is a constant subject of investigation.

Equilibrium and rate data for the absorption of CO2 in organic amine solutions are given by Gailer et al.16. The object of their investigation was to obtain data under conditions which simulated static equilibrium. This was achieved by approaching equilibrium dynamically by agitating the absorbent liquor, closing the absorption vessel and then allowing equilibrium to be attained statically. Initial rates of absorption were measured with an electronic pressure gauge capable of recording pressure changes effected by a single drop of absorbent falling through the gas during a contact time of 10⁻³ sec. This instrument¹⁷ was sensitive to pressures of 10-3 cm. Hg. Variations of the solubility of CO2 with partial pressure and temperature are given for monoethanolamine and Abrac Lye, and variations of absorption rates of CO2, at constant volume. with concentration and surface area, for monoethanolamine and dipiperidyls.

Advantages Discussed

The advantages and disadvantages of CO₂ absorption by amine solutions and alkali carbonates are discussed by Dee¹⁸. Equilibrium data and calculations for the size of the regenerators are given. Based on the cost of absorption and regeneration of CO₂ diethano'amine was found to be better than the mono-, but the use of alkali carbonates (e.g. 3N solution of K₂CO₃) was also a sound economic proposition when the deterioration and loss of costly amines were considered in the former processes.

Groves et al.19 describe the regeneration of monoethanolamine in a continuous CO: absorption plant. The unit had a maximum capacity of 180 gal. per hr. liquor rate and a CO2 removal of 70 lb. per hr. All parts in contact with liquor were of stainless steel. The regeneration column was 14 in. dia. packed with 6 ft. of 1 in. Raschig rings, and a reflux distributor and a rich liquor distributor were located at the top of the pack-Another rich liquor distributor was provided near the bottom of the column. Factors favouring the absorption side of the process were found to be: minimum water and CO2 contents of the amine liquor, increased temperature of the amine liquor up to at least 120° C and an increased lean liquor rate. Design problems are discussed.

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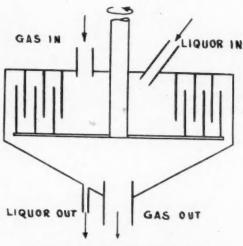
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Piazza-type centrifugal absorber

Ayerst and Herbert describe the pilot plant development for the continuous production of a 25-30 per cent solution of ammonium carbonate from a 10 per cent aqueous solution of ammonia. CO2 is absorbed in NH3 in an agitated vessel. Empirical equations are suggested for the calculation of the absorption rate. It is concluded that the absorption rate in strong NH3 solutions is a linear function of the free NH3 concentration in the bulk of the solution. The only safe method for scaling-up is the use of an absorption rate per unit volume obtained on a geometrically similar laboratory unit, maintaining the power consumption per unit volume constant.

Synthetic gas, used for the production of hydrocarbons by the Fischer-Tropsch process, contains CO2 which acts not only as a diluent but also as a depressant of catalyst activity. The efficient removal of CO2 from synthetic gas has been the subject of much research in the US. Two methods of removal are available, namely amine and alkali carbonate absorption. The plant purification of synthetic gas with diethanolamine in a 30 in. dia. column packed with 35 ft. of 11 in. Raschig rings is described by Wenzell et al.21. A comparison between the absorption with amines and hot K2CO3 solutions at 200-300 psi, was made by Benson et al.22 on a pilot plant scale with a 4 in. dia. column packed with 9 ft. of ½ in. Raschig rings. Although comparable overall transfer coefficients were obtained, the carbonate method was less costly due to the elimination of heat exchangers and coolers from the plant and the avoidance of amine loss.

Howard²³ also gives plant data on CO absorption by water and the ethanolamines. The particular problem here was to prepare N₂ of a high purity from air to be used as a controlled atmosphere in metallurgical and chemical processes. Coal gas and air were burned to remove O₂, but CO₂ removal by water under pressure was not successful. However, additions of ammonium phosphate increased the absorptive capacity of the liquid considerably. A plant using ethanolamines is described.

Centrifugal Absorbers

The absorption and recovery of CO₂ from exhaust gases and other gaseous mixtures using amines in mechanical absorbers is dealt with in three papers^{24,25,26} which provide much data for the design of such units. An absorber of this type, based on the design of a still head proposed by Piazza, is shown in the diagram.

A horizontal rotating plate carries vertical rings which intermesh with rings attached to the absorber head. Liquor is fed to the centre of the rotor plate from which it rushes towards the first rotor ring and up its vertical The liquor is wall by centrifugal action. then flung off the rim in the form of a spray and strikes the adjacent stator ring. Some of the liquor is reflected from the stator ring as a fine spray which mixes with the spray from the periphery of the first rotor ring while the remainder falls and joins the main This process is repeated liquor stream. until the liquor hits the outer walls of the absorber and finally flows through the bottom outlet. Gas can be made to flow coor counter-currently to the liquor. In each case efficient gas-liquid contact is obtained in the spray regions between the rings.

Dixon²⁴ studied the absorptive mechanism in small laboratory units, from 10 to 14 in dia., and a transparent casing enabled the spray pattern to be photographed. Data are presented on spray formation, droplet size in relation to the liquor rate, flooding carry-over, absorption rates, regeneration heat requirements, etc.

For the performance work, the system CO₂/monoethanolamine was chosen. It was found that the absorption efficiency is high during the droplet formation. Increase of the rotor speeds increased the linear velocity of the liquid at the rims of the rings and increased the degree of turbulence: it also

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decreased the droplet size which would further increase the turbulence, so the absorption rate would also be expected to increase. This was confirmed on a larger unit. Liquor blocked the gas passages when flooding occurred and the absorption efficiency was seriously affected. The deterioration in the performance after the flooding point was found to be much more rapid than in ordinary spray columns, but flooding could always be cleared by increasing the rotor speed. The effect of design features on flooding are also discussed.

Work of a similar nature, but on a larger unit, is reported by Chambers and Wall²⁵. The size of the absorber was 21 in. dia. and 10 in. deep, and it was capable of treating 21,500 cu. ft. per hr. of air containing 14 per cent CO2 to give a gas containing 2 per cent CO₂ (=310 lb. per hr. CO₂), while using 225 gal. per hr. of monoethanolamine as absorb-Flooding conditions, pressure ent liquor. drops and absorption data are given and design features are discussed. The unit was driven by a 2½ HP motor and the power consumption was found to be a function of the liquor rate L. Over the flow range L = 200 to 2,000 lb. per hr. the power required was governed by the equation

$$HP = \frac{L}{670} + 1.65$$

A double rotor centrifugal absorber capable of handling viscous absorbent liquors is described by Alcock and Millington²⁶. In this apparatus the upper rings are not attached to the head of the absorber, as in the Piazza-type unit described above, but are fixed to a plate which is connected to the rotor so that both sets of rings rotate together. The method of operation is similar to that for the Piazza model, but the driving power requirements are reduced considerably since the spinning liquid is not alternately retarded and accelerated. The system CO2/monethanolamine was used in a 12 in. dia. apparatus. Less tendency to flooding was noticed than in a Piazza-type absorber, but the disadvantages were the heavier construction required and the need for a gas seal across the top of the rotor.

Miscellaneous Absorption Equipment

The use of the jet or Venturi scrubber is described in two papers. Johnstone et al. a describe gas absorption and aerosol collection in this type of apparatus. The absorp-

tion of SO₂ by alkaline solutions, absorption of O₂ by water and the desorption of CO₂ from aqueous solutions were investigated. Rates of transfer in the atomisation zone were studied, based on the concentration changes in the droplets collected after short exposure times. Transfer coefficients were found as functions of the distance from the nozzle and of the gas and liquid rates.

Sherwin²⁸ gives data on the use of the Venturi scrubber for removing fluorides (e.g. SiF₄) from superphosphate den gases. In this work, a spray tower and a tower packed with rectangular wooden grids were also used. The performance, based on the volume transfer coefficient K_Ga, was found to be highest for the Venturi scrubber and lowest for the spray tower.

Fibre Beds

The recovery of soluble gases and aerosols from air streams in a washer fitted with irrigated fibre pads has been reported by Berly et al. 24. This particular apparatus was designed to recover gaseous and solid fluorides. Vinyl plastic fibre beds were inclined at 45° to the air stream and nozzles located above the pad surfaces irrigated them with water. The results indicated that the unit was 5 to 10 times more efficient that Raschig ring packed towers and pressure drops were low. The unit is also suggested for use as a hydrochloric acid absorber and as a scrubber for AlCl₃ fumes, etc.

Some problems met with in the coal gas industry are discussed by Silver 30. A number of washers for specific absorptions, and factors affecting the choice of plant, are described. The absorption of CO2 by alkaline and ammoniacal solutions is shown to be low-rate due to the slow rate of reaction of CO2 with -OH ions and dissolved NH2. The absorption of NH3 by aqueous solutions is discussed and a method of determining the efficiency of ammonia scrubbers is put forward. Coal gas has to be dried before it is introduced into the mains, and moisture removal is effected by washing the gas with a concentrated solution of CaCl2. Performance curves for this operation are given and it is shown that it is advantageous to cool the gas completely before passing it to the drying plant.

Two papers deal with vacuum de-gasification. Oetjen and Gross²¹ describe the degasification of liquids in a high-vac still fitted with an inner, thermostatically heated spiral

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down which the liquid flowed. Absorption isotherms for N_2 in glycerol, dibutyl phthalate, trichlorodiphenyl and an insulator oil obeyed Henry's Law: $x \propto p$ (x = concentration, p = pressure). The isotherm for water in the last three solvents showed that $x \propto p^n$, where n is a constant. A 3-stage de-gasification plant for handling 3 tons of oil a day is described.

Knoedler and Bonilla³² studied the deoxygenation of water in a 6 in. dia. column packed with 2 ft. of a Stedman triangular packing. Water temperatures from 52° to 112° F and liquid rates from 3,400 to 13,000 lb. per hr. per sq. ft. were employed. Noncondensable gas pressures ranged from 1 to 94 mm. Hg. and oxygen concentrations in the entering water ranged from 3 to 13 ppm. Complete absence of gas-film resistance was found, and below the loading point the data were correlated by the equation

 $HTU_{OL} = 0.078 L^{0.3}$

Film coefficients for the packing depended only on the liquid rate and showed no variation with the height of packing, solute gas concentration, pressure or temperature.

In an attempt to eliminate the necessity for a pilot plant stage in process development, Hoftyzer and van Krevelen33 consider the applicability of the results of small-scale experiments to the design of technical-scale absorbers. They propose that if the rate of physical mass transfer in the technical apparatus is known, then the laboratory tests will suffice to determine the rate of chemical reaction. From the combined information, the rate of the chemical absorption process in the technical plant can be predicted. absorption of CO2 in alkaline solutions is discussed by way of an example, and a method of calculation is proposed which agrees well with published data.

Characteristics of Old & New Packings

Pressure drops, loading and flooding data for various types of absorption equipment are reported by a number of authors. Sakiadis and Johnson³⁴ derived spray columns matheing rates in liquid-liquid matically for gas-liquid, interactions, and solid-liquid packed columns for gas-liquid and liquidliquid contact. Leva³⁵ investigated flow through irrigated, dumped packings and proposed a number of empirical equations for pressure drop, loading and flooding.

Hoffing and Lockhart³⁶ present a correlation of flooding velocities in packed columns.

Their work was carried out in a 6 in. da column packed with 12, 3, and 1 in. Raschit rings, and flooding points were determine for liquid-liquid extraction. The result were applied to gas-liquid contact. The conclude that examination of the change pressure drop readings may give a hint of the approach of flooding, but this is not a good as a visual determination. drop was shown to be a function of the hold-up, but pressure drop readings coul not be used to correlate flooding velocities Their correlation is by a non-dimension factor incorporating fluid densities, bull velocities, interfacial tensions and packing characteristics. Gas flow characteristics a disc-type absorption column are given by Warner37 who carried out pressure drop measurements with counter-current water and gas streams. Empirical correlations and presented.

Effect of Supports

The effect of packing supports on the mechanical operation of packed towers discussed by Leva et al.38. Flooding limit pressure drop and general flow capacities at reported. They found that pressure drop may increase up to 50 per cent if unsuitable supports are chosen, especially if high liquit rates are employed. However, the provision of a support with a large free space does not necessarily guarantee good tower open tion because the packing characteristics relation to the supports are an important feature. Support plates of a weir-type at described which provide separate flow chair nels for gas and liquid, and obstruction the openings by packing elements is minmised.

The grid-tray, in various forms, as a pack ing for gas-liquid contactors is finding in creasing use in the chemical and petroleur industries. Garner et al.30 investigated the pressure drop characteristics for these trays Water rates up to about 5,000 lb. per in per sq. ft. were employed with superficial at velocities up to about 4 ft. per sec. Date are presented for various slot widths and but sizes. The design and operation of a sieve plate column is reported by Pozin et al. In this apparatus the kinetic energy of the gas is used to convert the gas-liquid system into a vigorously moving, unstable foam ! increase the inter-phase contact. The effect of gas flow was studied in different design of the column, and optimum hydrodynamic conditions are discussed.

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Another new type of gas-liquid apparatus is the co-current pipe-line contactor. Basic data on flow patterns, pressure drop and liquid hold-up are presented by Alves41. The isothermal flow of water-air and oil-air streams were investigated in a 1 in. dia. pipe and photographs show conditions existing in straight pipes and return bends. Numerous correlations are given which may be useful for plant-scale contactors, but no scale-up information is available. The evolution of the cross-flue grid packing used in gas scrubbers, water coolers and other plant is traced by the author42. Many tower packings regarded as new today are shown to have been invented and used in the last century.

Use of Saddles Discussed

The use of saddles as a packing for counter-current heat and mass transfer equipment is discussed by Heckmann and Krell⁴³. Considerations of the aerodynamic form of these packing elements indicate that their performance should be better than that of conventional rings. These factors are discussed in relation to absorption, distillation and other counter-current operations.

The introduction of new packing elements is a commonplace occurrence these days, but a few recent ones deserve some mention. An element called the Rosette has been developed in the US. Teller4 reports performance data for this packing. The elements are described as being 'shaped in the form of a helical torus, or more simply, a multiple helix in the form of a doughnut.' However, in spite of the difficulty of putting its shape into words, the performance of this packing is promising. A 4 in. dia. coil gives a Rosette of 2 in. outer dia. with a surface area of 97 sq. ft. per cu. ft., compared with 36 sq. ft. per cu. ft. for 1½ in. Raschig rings and 50 sq. ft. per cu. ft. for 1½ in. Berl saddles. Performances of Rosettes made of polyethylene are compared with glass rings and saddles and transfer efficiencies, on an air-NH_s/water system, exceed those of rings and saddles by 35 to 125 per cent. At high liquid rates the values of HTU and pressure drop for the Rosettes were independent of the liquid rate. The use of an easily wetted packing material should improve the efficiency of the Rosettes even more.

Another new packing element of promise is the Pall ring reported by Pfannmüller⁴⁸. In shape and external dimensions, this element is similar to the Raschig ring, the difference being that the inside contains a number of 'spokes.' These are formed by pressing material out of the walls in towards the centre of the ring. The openings left in the walls provide a greater permeability than conventional rings and the contact surface is said to be increased by 20 per cent for thick ceramic elements. Both liquid entrainment and pressure drop are claimed to be better than for Raschig rings, but fabrication costs may be quite high.

A packing for distillation columns has been designed at AERE, Harwell⁶⁶, and no doubt it can be used in other gas-liquid contact processes. This packing has been tentatively named 'Spraypak,' and it consists of a cellular structure made from expanded metal mesh. Performance data for this packing are encouraging.

Information on many types of packings used in distillation and absorption towers is given in a number of articles which formed part of a symposium held in the US this year.

Gas & Water Cooling

Work on the cooling and dehumidification of air with refrigerated brine was carried out by Norman et al.45 The object was to determine transfer coefficients for the liquid film. The packing consisted of 6 ft. of carbon grids 6 in. long, 1 in. deep and 1 in. thick pitched at \(\frac{3}{4} \) in. Air rates from 1,415 to 2,330 lb. per hr. per sq. ft. and liquid rates from 1,300 to 4,000 lb. per hr. per sq. ft. were employed. Values of HTU₀₆, calculated by the total heat method, were found to range from 2.5 to 4.6 ft. and these were about twice as great as those obtained from water cooling and absorption experiments carried out in the same apparatus. Values of HTUL ranged from 2 to 5 ft. and HTUL was found, surprisingly, to vary with the gas rate.

The high values of HTU_L were first suggested to be caused by a high liquid-film resistance, but further work showed that the degree of wetting of the packing was a contributing factor; the liquid film on the slats became irregular when warm air was blown over the packing surface. This was not witnessed when the unit was operating as a water cooling tower.

To simplify the calculation of absolute humidities of air-vapour mixtures, Stern⁴⁰ gives a nomograph based on wet and dry bulb temperatures for mixtures of air and water, acetone, benzene, carbon tetrachloride, ethanol, methanol and isopropanol. The use of sorption in gas and air drying is discussed by Waterhouse 10. An economic survey is made of dehumidification by cooling and moisture removal by adsorption or absorption with liquid and solid sorbents. The applicability of the various methods to specific operations is considered.

Calculations of heat loads and a description of design features of industrial cooling towers is given by Degler 1. Trowbridge and Hayter⁵² describe the structural aspects of cooling tower selection, with particular reference to mechanical draught towers. arrangement of splash packings and water distributors and the merits of various mechanical equipment are discussed.

A report has been published53 on a study of abnormal wood decay in water cooling To minimise biological infection of the wooden packings, it is recommended that the pH of the water is kept between 7 and 7.5. It is also advantageous to keep chlorine residuals below 1 ppm, and to maintain the inlet water temperature below 120° F.

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Sales Still High

CHEMICAL industry sales in the US during 1954 are expected to approximate to the record 1953 figure of \$19,865,000,000, at cording to Chemical News, journal of the Manufacturing Chemists' Association. U to September, sales of chemicals and allied products reached an estimate figure of \$15,185,000,000 compared will \$15,122,000,000 for the same period of 1953.

Profits after taxation will also probable be in line with the 1953 figure to \$1,053,000,000. Cash dividends paid by the chemicals and allied products industries the first six months of 1954 wer \$325,000,000, or 13 per cent of all cast dividends paid by manufacturing industris

New Factory to Start Soon

The £2,000,000 British Celanese factory on Wrexham's trading estate is expected to start production in the spring. Work on the new factory began in April, 1950, and most of the buildings are now completed and machinery is being installed.

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Recent Advances in Chelatometry

by DR. RUDOLF PRIBIL,
(Pharmaceutical & Biochemical Research Institute, Prague)

ETHYLENEDIAMINE-TETRA-ACETIC acid, known in Europe as Complexone, Sequestrol or Enta acid and in United States under the trade names Versene, Sequestrene or EDTA, has, because of its remarkable complexforming properties, achieved so wide a use in all branches of analytical chemistry in a relatively short time that it must be counted by far the most extensively used organic analytical reagent.

The development of this reagent required a rather different approach from that generally used in the study of organic analytical reagents. Complexone does not form precipitates with cations—rather does it inhibit the majority of precipitation reactions with both classical and modern organic reagents. Nor are the colour reactions given by complexone at all marked. It may be that these are the very reason why this reagent escaped the attention of analytical chemists for so long, though the compound itself has been known since about 1935 or 1936 and its use as a water-softening agent has been patented.

Schwarzenbach's Work

It was not until Schwarzenbach in 1945 published his fundamental theoretical work on ethylenediamine-tetra-acetic acid and certain related compounds that detailed studies on its analytical utility were initiated. At the Charles University in Prague we have been engaged in such investigation for some years now, and have developed applications of the reagent in gravimetric, colorimetric and polarographic analysis, in amperometric work, iodometry and qualitative analysis. The results of this work have been published in a series of more than forty papers in the journal Chemické Listy, and most of these papers have also appeared in English translation in the journal Collection of Czechoslovak Chemical Com-munications. Much of this earlier work has been very adequately summarised recently by Dr. E. G. Brown in two reviews published in Metallurgia.

In the last two years the attention of our group in Prague has been occupied particularly by application of complexone as a volumetric reagent. These so-called complexometric titrations were, as is well known, introduced into analytical chemistry by Prof.

Schwarzenbach and have in a short space of time found extensive application in analytical practice. Since the reactions of compounds of the complexone type with cations, on which these volumetric methods are based, consist in the formation of chelate complexes, the name chelatometry has been proposed for this branch of volumetric analysis.

Versatile Reagent

Ethylenediamine-tetra-acetic acid differs from the majority of other precipitating, complex-forming or redox reagents used in volumetric analysis by its very wide range of specificity. At the present time, volumetric methods using complexone have been worked out for the determination of some 15 to 20 cations. Many of these cations could previously be estimated only by indirect methods, and for some no really suitable methods of any kind were available. This great versatility of the reagent poses a number of highly interesting, but frequently rather complex, problems where several components are to be estimated in a single solution.

These problems may be tackled essentially in one of four ways:

Firstly, by varying the pH of the solution, when the determination of its several components can be carried out at different pH values.

Secondly, by a suitable choice or combination of methods of isolation — extraction or precipitation procedures. These can be applied either to the metal to be determined, or alternatively to interfering elements.

Thirdly, by a procedure based on the selective screening or conversely de-masking of certain cations

Finally, new possibilities arise from the use of more selective reagents of the complexone type.

The first group of methods—utilising changes in pH—is based on the fact that the complexes formed by complexone differ in the pH at which they exist. The majority of divalent cations form complexes which dissociate at pH values below 4, whereas the complexes of tri- and quadrivalent metals are stable at pH 1—3. Incidentally I might point out that for obtaining preliminary data on

complex formation and stabilities, the polarographic method has proved particularly useful.

Determination based on the different stability of various complexes at defined pH values requires the use of an indicator specific for the cations to be determined. Analytical procedures of this type are represented by the titration of ferric ion with complexone, employing Tiron or salicylic acid as indicator—a method developed by Schwarzenbach. A method developed by Schwarzenbach is the titration of thorium to alizarin S at pH 2—3. A number of indirect procedures using potentiometric indication have also been worked out, particularly by Pribil and Matyska.

Theoretically interesting examples are the successive titration of zinc or cadmium at pH 6 and of magnesium at pH 10 to Eriochrome Black T; and the titration of zinc using the redox-system ferricyanide—3: 3'-dimethylnaphthidine as indicator; both methods are due to Brown and Hayes.

Highly Specific

Recently, new possibilities have been opened up by the introduction of a new highly specific indicator—pyrocatechol violet—by Malát and Suk in Prague. This compound forms an intensively blue complex with bismuth ions in acid solution. When such a solution is titrated with complexone, the end-point is marked by a sharp colour change from blue to bright yellow. Volumetric solutions as dilute as 0.002 M may be used. The determination is not affected by as much as a five-thousand-fold excess of lead, or by aluminium, manganese, zinc, nickel, copper, cobalt, the alkaline earths, etc.

A similar method has been developed by the same authors for estimating thorium in acid solution in the presence of excess uranium and certain rare earths. By suitable adjustment of the pH it is also possible to titrate thorium and zirconium in a single sample using pyrocatechol violet. It may be predicted with confidence that the discovery of further specific indicators, combined with suitable control of pH, will still further extend the range of specific complexometric procedures in acid solution.

The second type of procedure I have mentioned, involving selective isolations by precipitation or extraction, may often be achieved by the use of suitable organic reagent. The simultaneous determination of cadmium and zinc may serve as an example.

First, the sum of both elements is determined by titration with complexone against Eriochrome Black T; the cadmium is then precipitated with sodium diethyldithiocarbamate and the complexone liberated is titrated with magnesium sulphate. The white cadmium precipitate need not be removed.

Another example taken from the same paper is the selective determination of lead in presence of bismuth. Bismuth oxychloride is precipitated from a hydrochloric acid solution of the two metals by dilution, and the weakly acid solution is treated with magnesium ethylenediamine tetra-acetate. A displacement reaction takes place whereby magnesium ions are liberated from the complex and the most stable lead complex formed. The magnesium liberated is then titrated with complexone in alkaline solution.

Zinc and cadmium may be determined in the presence of aluminium, magnesium and calcium if these metals are precipitated by the addition of ammonium fluoride. Again, there is no need to remove the precipitated fluorides³.

The third group of methods, based on selective screening, holds out more promise than the isolation methods just discussed. Some potent complex-forming reagents are capabled specifically screening certain cations against complexone and complexometric indicators. The most studied of these reagents has hithern been potassium cyanide, which can form complexes of the required stability with numerous metals. Much of the work in the field is due to Flaschka, who has developed number of micro-analytical procedures on the basis.

De-masking

Further possibilities arise from the use of de-masking' procedures, that is, the selective liberation of certain cations from their complex cyanides. Zinc or cadmium for instance may be 'de-masked' to complexone, even in the presence of cyanide, by formaldehyde of chloral in ammoniacal solution. This makes possible the determination of these metals in the presence of copper, nickel and cobalt Similarly the difference in the stabilities of the manganous cyanide complex and the corresponding complexes of zinc, nickel etc., makes possible the direct chelatometric determination of manganese in these metals.

A determination of nickel in presence of small amounts of cobalt based on the use of cyanide is the following³:—

The sample is treated with excess of complexone and back-titrated with magnesium sulphate, giving the sum of nickel and cobal.

Addition of hydrogen peroxide causes the formation of a blue cobaltic peroxo-complex. This complex is inert toward cyanide; addition of cyanide therefore causes the liberation of an amount of complexone equivalent only to the nickel present; this liberated complexone is again determined by titration with magnesium sulphate.

The use of cyanide, particularly in serial analyses, is objectionable because of its toxicity. Though these objections are at any rate partly of a psychological nature, the danger should not be underestimated. We therefore thought it highly desirable to substitute a non-toxic reagent of similar effectiveness for cyanide and our recent work with 2:3-dimercaptopropanol (BAL) has, indeed, shown that this will be quite feasible.

The screening of iron and aluminium in chelatometric work proved to be a problem which defied solution for a long time. Aluminium forms a reddish-purple complex with Eriochrome Black T which is stable to complexone and the indicator is thus 'blocked' and ineffective. Ferric ion reacts with the indicator even when the metal is first converted into its ethylenediamine tetra-acetic acid complex (for example by titration in acid solution). Attempts to screen these two metals by various organic acids, cyanide or a number of other reagents gave unsatisfactory results.

Difficulty Overcome

Recently this difficulty has been overcome by the use of triethanolamine⁴. This reagent efficiently screens aluminium in titration to both murexide and Eriochrome Black T. In sodium hydroxide solution iron is also bound sufficiently firmly to allow the titration of e.g. nickel or calcium against murexide. Chelatometry with triethanolamine as screening agent thus makes possible the realisation of hitherto intractable analyses such as the determination of zinc, cadmium or magnesium in presence of aluminium, nickel, cobalt, etc., and the problem of screening aluminium may be regarded as solved for normal analytical purposes. Ferric iron, however, even in the form of its triethanolamine complex, still appears to react with Eriochrome Black T. By using a combination of triethanolamine and cyanide as screening reagent it has nevertheless proved possible to work out chelatometric procedures for the determination of magnesium in cements and certain silicates5.

In general Eriochrome Black T cannot be regarded as an ideal indicator for chelatometry.

As has been pointed out, the complexes formed by iron and aluminium with the indicator are stable to complexone. The same applies to nickel, cobalt and copper. Pyrochatechol violet⁶, the new indicator mentioned before, is free from this drawback and can be used in the direct titration of cobalt and nickel in ammoniacal solution, as was shown by Suk and Malát⁷. The end-point is indicated by a change from the blue colour of the metal complex to reddish-purple. Magnesium, zinc and cadmium can also be titrated to this new indicator.

Screening Heavy Metals

Until recently no method was available for screening some of the heavy metals such as lead or bismuth. We have found that 2:3-dimercaptopropanol is a suitable reagent for this purpose⁸. It forms very stable ammoniasoluble complexes with a number of cations. Where these complexes are colourless, as in the case of lead, bismuth, cadmium and zinc, BAL may be used as a screening reagent in chelatometry. It is now possible for instance to determine the calcium content of lead-calcium alloys, without previous separation of the lead, within a few minutes.

Very interesting problems arise in procedures using combined screening. Many of these procedures increase the selectivity of complexometric titrations up to the point of complete specificity, and in addition they frequently make it possible to determine up to four to five cations in a single solution.

Nickel, zinc and magnesium may be determined in a single sample by the following procedure:—

The weakly acidic solution is treated with complexone in excess and the excess reagent back-titrated with magnesium sulphate to Eriochrome Black T in ammoniacal solution. Addition of BAL as a 10 per cent alcoholic solution leads to the formation of a BALcomplex with zinc alone; the complexone set free is again titrated with magnesium Addition of potassium cyanide sulphate. leads in the course of 3-5 minutes to the liberation of a further amount of complexone, equivalent this time to the nickel present, and again the reagent set free is titrated with magnesium sulphate. The amount magnesium originally present is obtained by difference. The whole procedure can be applied in the presence of aluminium if this metal is screened by the addition of triethanolamine. Combinations such as nickel-

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In the analysis of e.g. siccatives we meet with the combination lead-cobalt-manganese. Since cobalt reacts in part with BAL, even in the presence of complexone, the following modified procedure is required:—

The acid solution is treated with excess complexone and the excess back-titrated as before. Addition of cyanide now sets free an amount of reagent equivalent to the cobalt, and finally addition of BAL gives an amount corresponding to the lead present. These determinations should preferably be carried out in dilute solution, since high concentrations of manganese are liable to be a source of error. Similar procedures might be used for bismuth, cobalt and manganese, for lead, zinc and magnesium and so on.

Pb. Ni, Zn & Mg

As a final example I might mention here the determination of lead, nickel, zinc and magnesium. The sum of these ions is again found by back-titration. Addition of sodium diethyldithiocarbamate now causes precipitation of the white lead complex; the complexone liberated is titrated, and BAL added. This causes solution of the precipitate, together with liberation of complexone equivalent to the zinc. Nickel is determined by conversion to the cyanide complex as before. Again, aluminium may be screened with triethanolamine. Similar procedures can be used for cadmium-zinc-nickel, or for manganese-cadmium-zinc and other combinations.

Procedures such as these can be combined in various ways with other analytical dodges and adapted to any given problem. Our own practical experience in this respect is as yet limited; but application of such principles in chelatometry is, after all, in the hands of any analyst. By way of example, I might mention an application in the analysis of lead glass:—

After removal of silicic acid by evaporation with hydrofluoric acid in the usual way, the residue is taken up in an ammoniacal solution of triethanolamine in which the lead sulphate will dissolve readily and the sum of lead, zinc, calcium, magnesium and zinc determined by direct titration with complexone. Successive additions of cyanide and BAL, with titration after each addition, give the amounts of lead and zinc, and calcium and magnesium are found by difference. A second part of the residue is analysed for calcium by titration against murexide in sodium hydroxide solution,

with lead and zinc screened by BAL and iron and aluminium by triethanolamine. The whole analysis is very rapid and convenient.

Before passing on to the use of other complexone type reagents I should just like to mention the possibilities of thiomalic acid as a screening agent for increasing the selectivity of complexometric titrations. As is well known, this acid forms extremely stable complexes with certain cations-witness for instance the use of its aurous salt as an antirheumatic drug under the name Myochrysin. Preliminary experiments indicate that thiomalic acid9 will, for instance, screen iron and bismuth in acid solution, and so makes possible the selective titration of thorium against pyrocatechol violet in the presence of these metals

The fourth type of development in our classification is based on the use of more selective reagents of the complexone type for the successive titration of several ions in a single solution. This is as yet very largely a problem of the future. Since the structure of complexone type reagents is characterised by the presence of at least one grouping of the type N(RCOOH), their choice is necessarily limited, and no striking advance may be expected in this direction. Structural variations in the reagent molecule do indeed often lead to a more or less linear variation in the stability constants of the whole range of complexes with all cations. However, these stability constants are not the only criterion of the usefulness of a given substance as a volumetric reagent or screening agent. Other factors must be considered such as the rate of complexformation, the redox-potential of the complexes, the pH ranges of complex stability, etc.

Some Examples

A few examples may make this clear. Femiliaron, for instance, can be titrated against Tiron or salicylic acid at pH 2-3 using ethylenediamine tetra-acetic acid. The additional titration of say, zinc or magnesium after adding alkali is made difficult by the destructive action of ferric-complexonate on the indicator. In alkaline medium also iron is displaced from its complex by other cations and then precipitated. If we use a more potent complex-forming reagent for the titration of iron, precipitation is prevented and the redox potential decreased, so that both forms of interference are eliminated.

Polarographic experiments have indicated that 1: 2-diaminocyclohexane tetra-acetic acid

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has the required properties. It was, indeed, found that iron can be titrated with a solution of the disodium salt of this acid at pH 2-3 using salicylic acid as indicator, and the resulting solution can then be adjusted to pH 10 with ammonia-ammonium chloride buffer and used for the further titration of manganese or magnesium, etc.10 cannot, of course, be used as an indicator here because it forms complexes with many cations, including magnesium.

The complexes formed by diaminocyclohexane tetra-acetic acid also undergo displacement reactions much less readily than those of complexone. This fact makes it possible to determine e.g., copper, iron or aluminium indirectly, by back-titration with magnesium sulphate. In weakly alkaline solution (aqueous pyridine) the same method can be applied to titanium or the sum of titanium, aluminium and iron. If titanium and aluminium are screened by the addition of fluoride at different pH values, all three metals can be determined in one sample. In this case zinc sulphate is used to back-titrate the reagent.

Differences in Reactivity

There is also a considerable difference in the reactivities of cations in the presence of the ethylenediamine and diaminocyclohexane reagents. For instance, the complexes of nickel, cobalt and iron with diaminocyclohexane tetra-acetic acid are so stable that they do not react with potassium cyanide. On this fact we can base a number of further analytical procedures. Nickel and copper, for instance, may be determined in one sample by estimating their sum by back-titration with magnesium sulphate in the usual manner, treating the solution with hydroxylamine and cyanide and titrating the reagent liberated, corresponding to the amount of copper present10.

The stability of the complexes formed by this new reagent is also much greater in acid solution; in combination with specific indicators, this may lead to new direct chelatometric methods for determining a number of further metals.

These examples may suffice to indicate some of the possibilities offered by the use of diaminocyclohexane tetra-acetic acid as a volumetric reagent; work on various aspects of this problem is nearing completion and will be published in our journals. The reagent itself is, as yet, rather hard to obtain; but I am informed that the Geigy Company expect to market it soon at a reasonable price. Experiments are under way with some further new reagents which are still in process of being patented. First results are encouraging and the introduction of these reagents will very probably lead to a number of new possibilities.

This brief review of certain new principles in chelatometry shows that this method is likely to give rise to a very large number of practical analytical procedures which will undoubtedly lead to a considerable increase in the speed and accuracy of routine analytical checks and may be expected to cause the gradual disappearance of certain 'classical' gravimetric procedures from practice.

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This paper was to have been presented at the International Symposium organised by the Midlands Society for Analytical Chemistry in Birmingham from 25 August to 1 September, but owing to unforeseen circumstances, Dr. Pribil was unable to attend. We are very pleased, therefore, to take this

\$8,000,000 Plant Expansion

opportunity of publishing the paper.

Alaska Pine and Cellulose Ltd. will invest about \$8,000,000 in its Port Alice, B.C., Canada, mill, according to Mr. Clyde B. Morgan, newly-elected chairman. Morgan is also president of Rayonier Inc. of New York, producers of chemical cellulose, and he has signed a \$20,000,000 agreement giving Rayonier an 80 per cent interest in Alaska Pine. The \$8,000,000 will be used to increase the mill's capacity.

Production of Tantalum Oxides

Commercial production of oxides of tantalum will begin this month after a year of experiments at Thehboreal Rare Metals Ltd. refinery at Cap De La Madeleine, Quebec, Canada. The experiments resulted in some 500 lb. of commercial oxides, most of which have been sold.

Changing Frontiers

New Analytical Methods for Paint

MR. C. WHALLEY, of the Paint Research Station, addressed the London Section of OCCA on 15 December, on the subject of 'Changing Frontiers in the Analytical Chemistry of Paint Materials.'

Mr. Whalley recalled that six years ago he had addressed OCCA on analytical matters. At that time his subject was the application of microchemical methods in the oil and colour industries, and in the course of his lecture the various ways in which the relatively new techniques of micro-analysis could be applied to problems arising in the industry were discussed.

On this later occasion he dealt with some of the new analytical techniques which had come to the fore in the past few years. He did not attempt to detail a catalogue of specific methods for specific materials, but rather demonstrated the principles of some of the newer techniques and drew illustrations of their use from pertinent problems. He chose six of those techniques.

(1) Developments in micro and semi-micro procedures, including methods for the determination of oxygen and of cellulose ethers.

(2) Developments in spot tests and colorimetric methods, including new reagents for both organic and inorganic materials and the use of these methods for the determination of trace elements and minor constituents of pigments.

(3) Applications of paper chromatography, including the separation of fatty acids, polyhydric alcohols and triglyceride oils and the

use of the ring oven and paper electrophoresis.

(4) Applications of vapour phase chromatography, including the principles of the technique and the difficulties associated with the detection and determination of the separated fractions. Examples chosen were the separation of fatty acids, solvent mixtures and pyrolysis products of copolymerised materials.

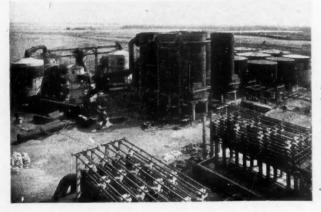
(5) Applications of ion exchange resins including the types and characteristics of exchangers, their methods of use and illustrations drawn from the analysis of pigments solvents, oleo-resinous systems and driers.

(6) Applications of complexones, including their use in the analysis of pigment mintures.

European Corrosion Union

THE European Federation of Chemical Engineering announces that it considers the time ripe for the formation of a European Union for the study of corrosion, and taking advantage of the organisation of the III° Salon de la Chimie et des Matieres Platiques, held a preliminary meeting in Paris on 11 December.

Fifteen associations from six European countries took part, and decided on the spot to constitute a European Union. A committee has been appointed to draw up tems of reference, composed of representatives from Germany, Belgium, France, Great Britain, Italy, Holland, Scandinavia and Switzerland.



Part of the United Sulphuric Acid Corporation plant al Widnes, which is expected to commence operations in April. On the left are the oxidation units, comprising catalytic converters and heat exchangers; SO₃ coolers are in the centre; and in the foreground are the acid coolers

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Current PVC Developments

by M. S. WELLING*

ALTHOUGH PVC has been known for a long time, it has only really come to the fore in Britain during the last decade. In 1944 production was 3,000 tons p.a. By 1953 it had reached 30,000-40,000 tons p.a. and it is estimated that by 1957 there will be capacity to make 60,000-70,000 tons of PVC.

New applications are continually being developed by chemists and technologists who are well aware of the great versatility of this material which, by varying the compounding ingredients and processing techniques, can be converted into a wide variety of different products which serve the need of many industries.

This article deals briefly with the main PVC developments in the principal fields of application.

Conveyor Belts

During the period of 1940-1950 faults on underground conveyor systems caused 75 fires, culminating with the Cresswell disaster in 1950 which caused considerable loss of human life and £200,000 damage. Following this accident, an extensive research programme was initiated by the Central Research Department of the National Coal Board. The results of exhaustive tests on a number of materials which might be used in place of the conventional but inflammable rubber led to the conclusion that PVC would fill that need. Today, a 100 per cent use of PVC belting in all British pits at the earliest possible moment is the joint aim of the National Coal Board, the mines and the coal industry. The Coal Board stipulated that as from 1 January 1954, 10 per cent of the total quantity of rubber belting in use underground should be replaced by fire-resistant PVC belting, this percentage to be increased and applied uniformly throughout the coalfields. This means that about 20,000 tons of PVC will be needed to replace the 19,000,000 ft. of conveyor belting in use in British pits at the present time. In addition to this, 10,000 tons of PVC will be required annually to replace worn out belting -about 10,000,000 ft.

Progress is also being made with the development of PVC treated fabrics for the manufacture of brattice cloth, 4,000,000 sq.

yd. of which are used annually in British mines. Brattice cloths can cause dangerous fire hazard unless adequately flame-proofed. The flame-proofing agents at present employed are not permanent, tending to lose their effectiveness after a period of use. The employment of PVC as the flame-proofing agent overcomes this defect.

PVC sheeting is making a serious impact on the rubber-proofing industry; this material is being increasingly employed in the manufacture of rainwear, particularly men's mackintoshes. According to a recent survey some 60-70 tons of PVC sheeting are used every week in making rainwear in Britain at the moment; this represents a consumption of about 1,000,000 yards per week—roughly 50 per cent of the total national weekly output of PVC sheeting.

The main outlet for thick PVC sheeting is undoubtedly in the floor covering industry. Easy to install and easily cleaned, PVC floor covering is ideal for use in shops, offices, canteens, as well as in the home, and because of its high resistance to corrosive liquids and other chemicals it is widely used for laboratories. It is estimated that the annual consumption for this purpose, which at present is about 3,000 tons, will shortly reach 10,000 tons. These figures include PVC used for the above type of floor covering as well as vinyl tiles.

Coated Fabrics

The use of PVC-coated fabrics in cars for hooding, seating, wall panelling, etc., has continued to increase. At the 1954 Motor Show PVC-coated fabrics were to be seen in Austin, Ford, Standard and Daimler cars. PVC-coated fabrics have now almost completely replaced linseed oil materials for the manufacture of 'oilskins.'

A more recent development in the coated fabrics field has been an increased popularity of fleecy-backed PVC, the chief outlets being jerkins and coats. Very attractive ladies' coats made of this material are now on the market.

The use of PVC-coated fabrics for wall panelling—in trains, factories and public

^{*}British Geon Ltd.

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houses—is also becoming increasingly apparent, an attractive feature being the permanence of these materials.

In the protective clothing field, PVC gloves which last about 10 times longer than rubber gloves, and formerly available only to industry, have been put on the domestic market.

A recent development in the cable industry is the more extended use of non-migratory plasticisers in the manufacture of PVC sleeving, enabling it to function efficiently in oil and to resist high temperatures without affecting its valuable electrical properties.

Very considerable expansion has occurred in the use of rigid PVC and it is clear that this will continue for many years, since it is a comparatively new material whose properties are only just beginning to be widely appreciated. The high chemical resistance of rigid PVC still makes news, as for example the report on a rigid PVC filter used for nearly 18 months in contact with acid plating solutions. A similar filter made of stainless steel lasted only three weeks.

Another important factor is the light weight of rigid PVC as opposed to steel, which is five times as heavy. This considerably reduces labour costs: for example, three men can lay down 4,000 ft. of 4 in. rigid PVC piping in a day. An equal length of steel piping would require eight men.

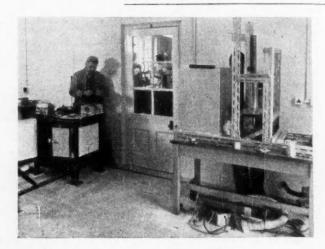
There is world-wide interest in the uses of rigid PVC. From Germany it is reported that Farbenfabriken Bayer, Leverkusen, have used more than 500,000 lb. of unplasticised PVC in their corrosion resistant installations.

In the US a provisional standard has been orafted which specifies minimum impact strength for normal, medium and high impact rigid PVC. A fairly recent development in the US is a combination of steel or aluminium sheet with rigid PVC, the bond being so strong as to permit 180° bends without separation of the laminate. The extrusion of unplasticised PVC tubing up to 15 in. in diameter and a wall thickness of ½ in. has been reported from Italy.

A comparatively recent development is the use of rigid/flexible laminates which provide excellent resistance to corrosive liquids at temperatures as high as 80° C and even 100° C as opposed to the normal top limit of 60° C. A typical laminate consists of a 20 thou, layer of rigid sheeting laminated to a 100 thou, layer of plasticised PVC. This has the advantage of producing a material of high impact strength, the flexible layer acting as a buffer, as well as facilitating easy bonding to the walls of vessels to be lined.

Mond Nickel Fellowships

The Mond Nickel Fellowships Committee announces the following awards for 1954;—MR. M. BROWNLEE (Dorman Long & Co.) to study British, Continental and American hot and cold metal basic open hearth steel-making; MR. R. D. BUTLER, B.Sc. (I.C.I.) to study mineral dressing practice; MR. F. B. PEACOCK (Dorman Long & Co.) to study rolling mill operation and maintenance; and MR. A. M. SAGE, B.Sc. (British Iron and Steel Research Association) to study the manufacture and fabrication of structural steels.



Ozone testing at the new laboratories of the Research Association of British Rubber Manufacturers, Shawbury. Ozone causes severe ageing of rubber, and by means of the testing cabinet it is possible to assess the quality of a sample

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Degradation of Plastics

by J. R. MAJER, M.Sc., Ph.D., A.R.I.C., D.I.C.

A GREAT deal of attention has been paid in recent months to the manner in which plastics materials are degraded and to the effects which a variety of radiations induce within them. The present review is confined to the many aspects of these processes which have been dicussed in recent literature.

A film of a plastics material, particularly of a vinyl resin, may 'age' in several ways. The simplest of these involves the loss of plasticiser to the surrounding atmosphere. Many attempts have been made to relate this type of ageing in films of polyvinyl chloride to the rate at which plasticiser is lost to the surroundings. In a series of tests1 it was found that the life of a film of polyvinyl chloride could be roughly predicted from oven tests. There was some relation between ageing and the rate at which plasticiser evaporated from the surface or diffused through the body of the film. Loss to a surrounding medium of oil or water was accelerated by the presence of solvents due to their swelling action. In these tests the effect of sunlight was not taken into account.

Three new tests have been devised to measure plasticiser loss into oil, water and dry powders. In the first two cases a formula has been evolved based upon the solubility of the plasticiser in the surrounding medium and the rate of diffusion. The increased loss observed when soap is added to the water is explained by the assumption that plasticiser molecules leaving the surface are captured by the soap molecules and prevented from returning².

American Symposium

The United States Bureau of Standards has published a symposium³ upon polymer degradation mechanisms. In this the ageing of polyvinyl chloride is related to the loss of hydrogen chloride and apparatus is described for the measurement of this loss. It is considered that the polymers are slowly hydrolysed by water, the process being accelerated by the presence of strong acids. The thermal degradation of polyvinyl chloride is essentially a dehydrochlorination. At temperatures between 150° and 220° C in nitrogen the thermal degradation proceeds at a diminishing rate as points of higher chlorine-atom lability which are normally present within the polymer structure disappear by dehydrochlorination.

The rate of loss tends to a constant steady state which is unaffected by build-up of hydrogen chloride in the surrounding atmosphere, while increase in η indicates a cross-linking mechanism.

In oxygen the rate increases because of the continuous generation of fresh labile chlorine atoms by an oxidation mechanism, the reaction being autocatalytic with respect to hydrochloric acid. The change in η indicates that both cross-linking and chain fission mechanisms occur, but the former predominate. Heavy metal stabilisers absorb hydrogen chloride in an atmosphere of nitrogen but in air they probably act as oxidation catalysts for the disruption of polyene chromophores.

Effect of UV Light

Ultra-violet light in the presence of oxygen at room temperature produces points of higher chlorine lability which are sensitive to heat; the points may be due to the presence of carbonyl groups formed by the attack of oxygen upon the free radicals produced as a result of the absorption of ultra-violet light energy⁴. That such active centres are produced has been demonstrated by the addition of butyl groups to the polymer when it is irradiated in the presence of dibutyl tin diacetate.⁵ Despite this the transmittancy of polyvinyl chloride film has been shown to be characteristic of the filler or pigment alone in visible light.

The mechanism for the photodegradation of sec-butyl chloride, which is the prototype of polyvinyl chloride, has been studied in acetone at a wavelength above 235mu. All the liberated hydrogen chloride originates from the decomposition of unstable 4-chloro-4methylhexan-2-one and 3:4-dichloro-3:4dimethylhexane derived from secondary reactions involving radicals formed by the removal of hydrogen atoms from the butyl chloride and acetone. A thermo-balance has been used to study the degradation of polyvinyl chloride and a relationship between the degree of polymerisation and the rate of decomposition as indicated by the loss in weight has been discovered6.

The stability of a number of polymers to degradation by benzoyl peroxide in benzene or chloroform solution at temperatures be-

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tween 65° and 100° C has been examined. While both polyvinyl acetate and polyvinyl chloride were found to be stable, degradation was shown by polystyrene and polymethyl methacrylate⁷. Resistance to degradation by fungal or bacterial attack may be achieved by the inclusion of fungicides or by the use of built-in plasticisers which provide no nutrient sites for growth.⁸ Stabilisation of polyvinyl chloride against heat discoloration is maintained by the inclusion of neutral zinc salts, calcium ethyl acetoacetate and epoxy compounds such as butyl glycidyl phthalate¹¹.

Comparison of the thermal and oxidative degradation of polyvinyl chloride indicates that the thermal decomposition is initiated at one end of the macromolecule while oxidative degradation is initiated at some point within the molecule. The process is conceived as a chain reaction terminated spontaneously.

Under exposure to heat, oxidation is not a factor in the degradation until a minimum level of dehydrochlorination is obtained. Hydrogen chloride does not catalyse the oxidation in the absence of light but it is a uniform catalyst for the dehydrochlorination process. Ultra-violet light catalyses oxidation after a brief induction period, while oxidation disrupts dehydrochlorination, ultra-violet absorption and colour formation. An efficient anti-oxidant for protecting polyvinyl choride against light should be an acid accepter.

Thermal Instability

The thermal instability of irradiated polymer is ascribed to premature completion of the induction period preceding oxidative attack. The rate of hydrogen chloride evolution can be expressed in terms of the separate reaction constants¹⁵. Another set of experiments has been described which appear to discredit the theory that hydrogen chloride has an autocatalytic effect upon the degradation of polyvinyl chloride ¹⁶, and it is suggested that the effect can be entirely explained upon the basis of free radical formation.

Polymers in solution such as polymethylmethacrylate and polystyrene have been degraded mechanically, by stirring with silica spheres²⁶. The rate of decrease in degree of polymerisation decreases with increasing concentration, but the actual rate of decomposition shows a maximum at a certain concentration. The controlling factor is the rate of diffusion apart of fragments before they can recombine. Electrostatic effects are observed with poly-

methylmethacrylate but not with polystyrene,

Plasticisers

The problem of producing plasticisers for vinyl resins which, while imparting elasticity to the structure, do not provide sites for the growth of organisms, do not evaporate into the surrounding atmosphere or decompose under conditions tolerated by the polymer still engages considerable attention. The solutions which are proposed fall into three main groups. The first of these comprises compounds of low volatility and considerable molecular complexity, but having molecular weights of less than 1,000. Examples of the first class selected at random from a very extensive patent literature include monoally dinaphthyl phosphates18, benzothiazyl mecapto-acetic acid esters19, aryl or aralkyl ether of divalent alcohols having 5-10 carbon atoms27, and sulphonamides with waxlike properties28.

The migration of plasticisers of this das has been studied in a simple manner by clamping a piece of the plasticised polymer between several sheets of hard polyvinyl chloride eat 20\mu thick. The amount of the plasticiser diffusing from the central specimen has been determined by measuring the gain in weight of the sheets or the loss in weight of the specimen. Plasticisers studied in this way include esters of phthalic and adipic acids mesamoll, and tricresyl phosphate²⁰.

As the plasticisers of this first class have become more expensive to produce as their structural complexity increased, attention has been directed to the production of low molecular weight polymers which are compatible with the resin and which are formed from comparatively inexpensive monomers. Members of this second class are the low molecular weight copolymers of ethylene and vinyl acetate. They are used for plasticising polyvinyl chloride, polyvinyl acetate and polyvinyl butyral.

It is interesting to note that neither los molecular weight polyethylene nor polyvind acetate is suitable for this purpose²¹. Another copolymer of similar structure is prepared from octene and allyl butyrate and has a molecular weight of about 1,000²². Linear polyesters have also been suggested, particularly those derived from sebacic acid and diols such as butane-1:3-diol or 1:2-propylene glycol. The polymers have a molecular weight range of 1,700-2,000 and are added in amounts up to 45 per cent of the weight of polyving

chloride. The resultant material is claimed to be of use in the manufacture of co-axial cables²³.

An alternative type of polyester plasticiser is that obtained by polymerising one or more esters of saturated fatty acids with β-γ unsaturated alcohols. Solution or emulsion polymerisation may be employed, but the process must be controlled to yield polymers having a molecular weight of less than 1,000 and a boiling point of more than 200° C at 1 mm. Hg²⁴. The copolymers of unsaturated acid esters such as allyl acetate and alkenes such as ethylene have also been claimed. The molecular weight is kept below 3,000 and the ratio of carbon atoms to ester groups adjusted to be between 5:1 and 14:1.

The unsaturated esters may also be those of polycarboxylic acids in which only one of the esterifying alcohols is unsaturated, or alternatively, esters of unsaturated alcohols and aliphatic acylated hydroxy acids, the hydroxyl groups of which are themselves esterified²⁵. Polyester plasticisers used commercially in polyvinyl chloride have been shown to give no primary skin irritation or sensitisation. No dermatitis attributable to the materials has been reported²⁹.

Another solution to the plasticiser problem is to select a compound which contains a structure which can confer elasticity upon the final product and also a grouping which is capable of copolymerising with the resin itself. These types of plasticisers have been called 'built-in.' As an example, copolymers of vinyl chloride and vinyl stearate have been developed by the Agricultural Research Service, US Dept. of Agriculture. The vinyl stearate which is obtained from inedible animal fats acts as an internal plasticiser. Copolymers of high vinyl stearate content are said to be similar in flexibility to standard vinyl compositions plasticised in the normal way. Those with low stearate content are rigid but are said to have a lower milling temperature than ordinary vinyl resins. In addition they may be cured with polyfunctional amines to give insoluble infusible products; compounding and curing temperatures are 200° F and 340° F respectively30.

Polymerisation

The mode of action of the catalyst in the polymerisation of vinyl monomers has been given more attention recently. It has been found, for example, that when vinyl acetate is polymerised at 40° C in the presence of 1 per

cent of a meta or para substituted benzoyl peroxide, the rate of reaction is nearly proportional to the square root of the dissociation constant of the parent benzoic acid under the same conditions. The thermal decomposition of the peroxide, which may be followed iodometrically, is a first order reaction at 40° C but may change at a higher temperature. The catalysts fall into two classes of activity, the more effective being those containing electron release substituents. Of these only the p, p'-dimethoxy-benzoyl peroxide released carbon dioxide at 40° C, although all did so at the higher temperature. The rate of polymerisation of vinyl acetate was affected both by rate of decomposition of the catalyst and its activity31.

A Useful Catalyst

bis (p-Hydroxy-benzoyl) peroxide, prepared by the action of aqueous sodium peroxide upon a benzene solution of p-hydroxy-benzoyl chloride, has been used in a mixture with adipoyl chloride. Molecular equivalents are used as it is important that the components should be completely condensed with each other. One per cent of the catalyst mixture is capable of giving a clear thermoplastic polymer in three minutes at 370° C. Under similar conditions benzoyl peroxide gives a friable product³².

Adipoyl chloride has also been claimed in admixture with hexamethylene diamine as a catalyst for vinyl chloride polymerisation³⁸. bis (p-Hydroxy-benzoyl) peroxide has also been used with glyoxal in molecular proportions to produce mouldable polystyrene at temperatures above 100° C, thus speeding up the rate of reaction³⁴. Another new catalyst which requires no additional metal salt is a dimethyl-halophenyl-hydroperoxy-methane³⁵. Methyl methacrylate is said to be polymerised at room temperature in the presence of α-hydroxy and α-amino-sulphones or salts of sulphonic acids with organic bases³⁶.

The polymerisation of unsaturated compounds is initiated by the presence of free radicals. One of the earliest methods of producing these was to irradiate the monomer with ultra-violet light, the energy absorbed producing activated molecules. Patents based upon this principle are still being taken out, a recent example describing such a process in the presence of an ammonium salt of a diazosulphinic acid and a metallic ion. Such a combination is said to permit a polymerisation of doubly unsaturated compounds, e.g.

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divinyl benzene, diallyl maleate and butadiene, at low temperatures in aqueous suspension³⁷ Recently it has been discovered that although light usually has the effect of degrading a polymer, a primary result of irradiation is the production of active centres at positions along the polymer chain. These may become points at which rupture occurs, but if a monomer such as acrylonitrile is present they become the sites for branching of the polymer chain³⁸.

Becquerel Effect

An examination of the Becquerel effect has led to an understanding of the manner in which dyes may absorb light and pass the absorbed energy on to chemical systems39. It has been found, for example, that one of the direct results of the absorption of light by a dye is the production of free radicals and these are capable of initiating polymerisation. It has thus become possible to polymerise unsaturated compounds with visible light. A solution of fuchsine was used to polymerise methyl methacrylate when irradiated by the light of a 60W lamp. Since a very slight amount of polymerisation was observed in the dark it appears probable that the free radicals are excited dye molecules rather than hydrogen atoms or hydroxyl radicals.

Earlier attempts were made to extend the spectral sensitivity of monomers by the use of dyes as photosensitisers, but when carried out in the absence of oxygen only very low quantum yields were obtained for conversion of the monomer⁴⁰. It has been shown that these yields may be generally enhanced if both oxygen and a mild reducing agent are present⁴¹. Under these conditions the reaction mechanism must be different from that mentioned above.

Acrylonitrile is readily polymerised in aqueous solution when irradiated with visible light if the solution also contains a mild reducing agent, such as ascorbic acid or phenylhydrazine, and a photosensitiser of the fluorescein type such as phloxine, eosin, rose bengal or erythrosine-provided that oxygen is present¹². The polymerisation does not take place in the absence of oxygen, the dye being merely reduced to the leuco form with a low quantum yield. It is suggested that an essential part of the reaction mechanism is the interaction of oxygen and the reduced form of the dye to yield hydroxyl radicals which then induce polymerisation. The pure monomer may be polymerised by light if it incorporates small quantities of acriflavine and acidified stannous chloride. Another successful combination is liquid styrene, phenylhydrazine and rose bengal.

There is an interesting parallelism between the efficiency of dyes for photopolymerisation and for photographic sensitising. Triphensymethane dyes are ineffective, while Rhodamine B and Brilliant Green show a positive effect Azine dyes in trace quantities, particularly Pinakryptol Green, are inhibitors for photopolymerisation, photographic emulsions and the photoreduction of fluorescein dyes.

Monomers that are themselves reducing agents, e.g., acrylamide and N vinyl pyrrol done, may be polymerised without the addition of a reducing agent by easily reducible due such as riboflavin. The molecular weights the polymers obtained are extraordinarily his (in the order of 8,000,000) probably due to the reaction proceeding at low temperature. the monomer-dye mixture is subjected to single millisecond flash from an electronic flash lamp, polymerisation takes place after an initial induction period, being complete in 24 hours. This does not occur in the absence of oxygen and it is assumed the the free radicals responsible for the polymeristion are not in this case excited dye molecule but hydroxyl radicals produced in a secondar reaction between the reduced dve and absorbed oxygen. The photosensitise polymerisation of vinyl chloride, using 2:2azoisobutyronitrile and 1:1'-azo-cyclohexan nitrile as initiators43, has been studied kinetically.

Analysis

There has been a need for a method of identification of the wide range of polymer now in industrial use. The only available previous methods have been infra-red spectro scopy used in conjunction with pyrolyse The apparatus is expensive and the technique specialised. A new method44 is in the process of development which has many advantages It is based on the gas-liquid partition chromate graphy of the pyrolysis products of the polymers upon a Celite/dinonyl phthalate bu at 110° C and involves the recognition of characteristic patterns upon the resulting recorded chromatogram. The sensitivity sufficient to permit the differentiation polymethyl and polyethyl methacrylates, and among other vinyl resins which have already been identified are polyacrylates, polyiso butene, polyvinyl acetate and mixed polymer of butadiene and styrene or acrylonitrile. The range is to be extended by the use of a silicon y 1955

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DF, 550 column operating at higher temperatures so as to include those polymers which do not give a low boiling fraction upon pyrolysis such as polychloroprene.

It is probable that this method of analysis could be applied to the whole range of vinyl polymers, provided that the temperature of pyrolysis could be raised sufficiently high. At temperatures approaching 500° C even Teflon and other polymers of tetrafluoroethylene degrade to yield 100 per cent of monomer. A free radical mechanism is postulated as taking place at the ends of the chains, which progressively shorten45. Polyvinvyl fluoride, polyvinylidene difluoride and polytrifluoroethylene yield under the same conditions up to 34 per cent of hydrogen fluoride and waxlike fractions consisting of chain fragments of low volatility. Polyvinyl fluoride and polytrifluoroethylene are completely volatilised, but polyvinylidene difluoride is stabilised at 70 per cent weight loss. The composition of pyrolysis products of copolymers has been studied intensively by the use of mass spectrometry46,

Ionising Radiation

The effect of high intensity ionising radiation upon some polymers is to promote crosslinking, a process analogous to the vulcanising of rubber. Other polymers are degraded by main chain scission, a process differing from thermal or ultra-violet degradation. The extent of cross-linking, determined by solubility and swelling measurements, has been found to be roughly proportional to the radiation dose?

When polythene is irradiated with high energy electrons14 cross-linking occurs and the product no longer behaves as a linear polymer. The hydrocarbon and chlorinated solvents which dissolve polyethylene have no effect upon the irradiated product. It has improved form stability at elevated temperatures and the tensile strength and elongation have changed so that the material is elastic rather than plastic in nature.

The effect of the original molecular weight upon the extent of cross-linking has been studied47. It has been found that a sample of paraffin wax of average molecular weight 480 requires a dose of 9×108 R to convert it into an insoluble rubber-like material. With polyethylene it was calculated that a dose of 15×106 R produced an increase in molecular weight of approximately 4,000. The irradiated polymer cannot be used for long periods without degradation48.

Irradiation of polystyrene in an atomic pile results in a lower number of cross-linkages per unit of radiation than in polythene, which is said to be due to the stabilising effect of the benzene ring10. The effect of neutrons and Y rays on polystyrene and polyvinyl chloride has been studied; free radicals are produced, but degradation occurs only in the presence of oxygen13.

Paradoxically, ionising radiation may also be used for the polymerisation of unsaturated compounds. Vinyl chloride may be polymerised at constant pressure by the action of \gamma rays from radon gas. Both solid and liquid polymers are obtained, but some breakdown occurs with the production of hydrogen and compounds of low molecular weight. The number of molecules polymerised is proportional to the number of radon atoms disintegrated12. Ethylene has been polymerised by the radiation emitted from 60 Co at pressures up to 1,600 psi. After an initial induction period the polyethylene is formed rapidly up to a sharp maximum. The yields vary in amount and complexity but are unaffected by the presence of common impurities. - J.R.M.

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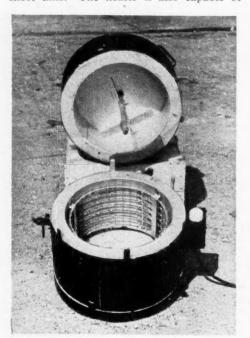
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Drum Heaters

Versatile Range Available

SEVERAL new designs are included in the range of Heron drum heaters, the selling and marketing of which was recently taken over by Houseman & Thompson Ltd., the industrial water treatment specialists, of Newcastle-upon-Tyne.

The heater is the invention of a Newcastle man, Mr. A. G. Heron, and is designed to extract or liquefy materials such as grease, bitumen, resin, plastics and solidified chemicals contained in metal drums, in a very short time. The heater is also capable of



The Heron '5' heater. Clearly visible is the stirring paddle; the heating element can also be seen in the lower half, while on the right-hand wall can be seen the thermostat control

completely drying moisture in drums which have been washed, in a matter of seconds

First to be produced was the Heron standard heater. This takes a 45 gal. drum but special sizes can be supplied to order In use the heater will empty a 400 lb, drun of bitumen in seven minutes. To use this model ceiling space to a height of at least 15 ft. is needed. The heater is lowered into position over a drum by means of a simple pulley with counter-balance.

For premises where space is limited, how ever, a new model is available. This is hinged version of the standard heater Mounted on four castor wheels it can be pushed into position, opened around the drum, closed and heating is then started

Another new model is the base heate only 3 in, high and 21 in, in diameter. The heating element is actually cast into the allo of this model and is invisible. A drum on be easily manhandled into position over the base heater which will fit inside the rim I the bottom of the drum. Complete liquifaction of any material is achieved quick when the base heater is used in conjunction with the standard or hinged models.

In the Heron '5' heater the heating element has been arranged to give uniform heat to the base and sides of a drum. A single thermostat is used to control temperatures up to 300° C. A hand-operated strring paddle is fitted through the top half cover to help speed up liquefaction.

Finally a model is available for use in dicumstances where it is necessary for the heater and drum to be lifted. A strong sup porting frame to take the combined weight is fitted and clamps, operated from the outs wall of the heater, grip the drum, allowing it to be lifted safely.

MR. CHARLES WHITELEY SHARP, of High cliffe, Hants, formerly of Halifax, chemical manufacturer, left £27,375 (net £26,924, dut) paid £4,806).

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Developments in Fuel Technology

by R. LONG, Ph.D., A.R.I.C., Assoc.M.Inst.Gas E., M.Inst.F. (Department of Chemical Engineering, University of Birmingham)

COAL is 'the material source of the energy of the country, the universal aid, the factor in everything we do's aid W. S. Jevons (the economist) in 1865, and although in recent years fuels derived from petroleum have played an increasingly important part in the national economy, coal is still the main source of energy in the United Kingdom.

In his presidential address to the Institute of Fuel, W. Idris Jones1 has reviewed the available power resources in Britain and has pointed out that although there are sufficient reserves of coal to last for a very long time, our long-term reserves comprise mainly low-rank coals which are non-caking or weakly-caking. He suggests that we can look forward to great developments in power generation; generators with up to 180-200 MW unit capacity will be quite common and more than three-quarters of the coal fed to power station boilers will be pulverised fuel. The efficiency with which fuel is utilised will show a considerable increase. However, this will not be achieved without considerable technical and scientific effort and such measures as coal-blending will be necessary in order to enable some of the lowerrank coals to be used for coke manufacture. An enormous and accelerated rate of capital investment will also be required in order to enable these developments to take place.

During the year under review the newly formed National Industrial Fuel Efficiency Service, a non-profit making organisation, has taken over the field of work previously carried out by the Fuel Efficiency Branch of the Ministry of Fuel and Power. Comprehensive services are offered to aid firms to secure fuel economy.

Air Pollution

The disastrous London 'smog' of December, 1952, led to a more active consideration of the old problem of air pollution.

The Committee on Air Pollution appointed by the Government has issued an interim report² which summarises the difficulties of the problem and makes recommendations for immediate action. The elimination of smoke, is of course, intimately tied up with the efficient use of fuel. It is believed that rather less than half the smoke is derived from domestic

chimneys, but most of the sulphur dioxide comes from industrial sources.

Dr. S. I. A. Laidlaw³ (Medical Officer of Health to the City of Glasgow) has reported upon the effects of smoke pollution on health and his opposite number in Salford, Dr. J. L. Burn⁴ has discussed the introduction of smokeless zones in that city.

At the Fuel Research Station measurements have been carried out upon the smoke from open fires and the results have been reported by L. L. Fox⁵. There is still comparatively little detailed information about the sources of atmospheric pollution.

The wider use of smokeless fuels is one means of reducing the amount of pollution, but it is necessary to consider the availability of such fuels.

Developments in the Gas Industry

The gas industry used over 28,000,000 tons of coal in 1953 and, by applying close technical control and by the concentration of production in the large and more economic units, an increase in the efficiency of gas production has been secured (71.6 therms per ton of coal in 1950/51 to 73.6 therms per ton in 1952/3).

Perhaps the most important gas-making process at present in this country is that employing carbonisation of coal in continuous vertical retorts. Steam is admitted at the base of the retort, and ascending the retort it reacts endothermically with the hot coke to produce blue water gas which augments and dilutes the coal-gas evolved by distillation of the coal.

An important development has been reported during the year and has attracted considerable attention. This is the so-called 'Rochdale' or 'carrier-gas' process which aims at the use of continuous vertical retorts with the minimum of steaming for the production of gas of high calorific value and the introduction of blue water gas (generated externally) into the base of the retort. Producer gas or coal-gas has been used as the 'carrier-gas' in the early experimental work, but the principle is the same, namely, to increase considerably the rate of heat transfer to the coal within the retort.

T. Nicklin and M. Redman⁶, who have described the process, claim that a considerable

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increase in thermal output per day can be secured from the retorts, together with other advantages. Although the principle involved is not new and has been employed previously in low-temperature and in oil-shale retorts, the potential importance of the process must not be minimised. Since the capital charges represent quite an appreciable proportion of the cost of gas, any increase in throughput, other things being equal, will result in considerable economies.

It is to be hoped, however, that if the apparent success of this process is amply confirmed, the gas industry will not thereby be deterred from pushing ahead with its research into more revolutionary methods of gas making and the erection of large-scale plants for complete gasification of coal.

Coal Gasification

The effective utilisation of weakly coking coals is one of the problems facing the gas industry and the results of research upon this topic have been described by F. J. Dent?. The Lurgi process which involves gasification in a mixture of oxygen and steam at pressures of up to 25 atmospheres has been studied further. In particular it has been found that coals of the 702, 802 and 902 types (NCB Classification) can be gasified successfully. The process offers considerable promise for the utilisation of coals not suitable for carbonisation and at least one of the Gas Boards is contemplating the installation of a large Lurgi installation. Meanwhile research is being actively pursued at the Birmingham Research Station of the Gas Council.

An important international conference on the total gasification of coal was held in Liège in May, 1954. Papers were presented covering oxygen gasification of solid fuels on the American Continent, problems of caking in the complete gasification of bituminous coals, the hydrogenation of coal to gaseous hydrocarbons and the mechanism of gasification of carbon. Further papers dealt with fixed bed gasification processes, and gasification processes in fluidised beds and in suspension. An interesting development reported was the gasification of coal under slagging conditions in the presence of iron ore so that in effect a combination of a total gasification plant and a small blast furnace is obtained with pig-iron and gas as the products. The conference papers have been reviewed by L. T. Minchin8.

Mixtures of carbon monoxide and hydrogen

are widely employed as synthesis gases for the Fischer-Tropsch, methanol and other synthesis and much work upon synthesis gas production has been carried out in recent years. The total gasification of coal dust has been discussed by F. Totzek⁹, who has described a Kopper-Totzek gasification unit built at Typpi Oy in Finland.

A working party of the Productivity and Applied Research Committee of OEEC but also published a report entitled 'Increased Thermal Efficiency through Gasification's in which a number of recent processes are reviewed.

The North Thames Gas Board is installing a complete gasification plant using the Ga Integral (G.I.) process.

Oil Gasification

In recent years considerable interest has developed in oil gasification processes. The reasons for this are threefold, namely, the relative shortage of coals suitable for carbonisation, the increasing price of coal generally, and the building of large refineries in the country with the subsequent availability of considerable quantities of heavy residual ful oils (black oils). There is an increasing demand for the gas oil fraction as diesel of for motor transport and as cracking-stock; moreover, heavy oil is cheaper than the distillate fuels so that there is an incentive to develop processes for the use of the heavy oils

Much effort has been devoted in the US to methods of using heavy oils for gasification, but they possess certain serious disadvantages their high viscosity means that heated pipeline and storage tanks are required and ordinary carburetters cannot be used in water-gas sets, for the residue of carbon would, on accumulation, soon render them inoperable.

One of the most popular methods of avoiding serious difficulty in using heavy oils in watergas sets has been to use an empty carburetter into which heavy oil is sprayed. The carbon residue is removed partly by burning off during the blow period and partly by periodical removal by mechanical means; often cleaning must be carried out daily. In another process most of the oil is sprayed on to the top of the coke fuel bed in the generator, and only about one-fifth goes into the carburetter.

J. G. King¹¹ has reviewed a recent series of tests carried out by the West Midlands Gas Board and Humphreys and Glasgow Ltd., into the use of heavy oil for carburetting. In these tests a standard 3,000,000 cu. ft. per day unit

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was employed and modifications were made to the carburetter. The process involved spraying the maximum amount of oil possible into the carburetter and, if the desired gas calorific value was not reached, injecting the remainder on to the generator fuel bed. It was found that heavy oils could be cracked so that the carbon formed could be continuously removed without interruption of the cycle.

Catalytic Gasification

The chemical reactions which occur during the cracking of oil are complex, particularly the stages which result in carbon deposition. However, hot carbon reacts with steam and this reaction is catalysed by alkali and alkaline earth bases. An investigation initiated in the laboratories of the former South Metropolitan Gas Company, described by H. Stanier and J. B. McKean¹², indicated that carbon deposition could be prevented during the gasification of gas oil in the presence of steam by the use of the above-mentioned types of catalyst.

A pilot plant investigation showed that similar results could be obtained with heavy fuel oil and the South Eastern Gas Board, in collaboration with the Power Gas Corporation Ltd., have erected a prototype commercial unit at Sydenham producing 800,000 cu. ft. of gas per day¹³. This plant works on a 6-min. cycle of operations and employs a fixed catalyst bed. Gas of 500 B.Th.U. per cu. ft. is produced by this so-called Segas process. The low specific gravity of the gas produced enables it to be mixed with coal-gas and the capital cost of the plant is low so that the cost of gas produced should compare favourably with that of base-load coal-gas.

The ONIA-GEGI process is a development of one devised by l'Office National de l'Azote for the preparation of ammonia synthesis gas from heavy oil. The above organisation, in collaboration with Humphreys and Glasgow's associated company in France (GEGI) operated a pilot plant for the manufacture of a town gas from heavy oil at Cahors^{14,15}.

A larger plant of about 1,000,000 cu. ft. per day gas output has been built at Stafford for the West Midlands Gas Board. The process involves spraying heavy oil on to a catalyst while steam is admitted from a waste heat boiler; some carbon is deposited and this is burnt off during the 'heating period' in which the catalyst is restored to its working temperature.

Other Gas Boards are proposing to erect catalytic oil gasification plants in order to gain experience of their operation¹⁶.

Natural Gas

The possibility of finding natural gas has led the Gas Council to embark upon an extensive field investigation to be carried out over a five-year period. The work is being carried out by the D'Arcy Exploration Company and drilling is taking place in a number of locations where natural gas might possibly be expected.

Extraction & Utilisation of Firedamp

Methane occurs in association with coal seams and is, of course, a considerable nuisance and danger during mining operations. Methane drainage from the rocks above and around the coal seam has been employed on the Continent and to some extent in this country, notably at the Point of Ayr colliery in North Wales. The subject has been reviewed by L. T. Minchin¹⁷.

J. R. Simonson¹⁸ has dealt with some combustion problems of the dual-fuel engine. This is an internal combustion engine of the compression-ignition type which burns gas and diesel fuel simultaneously. An advantage of this is that a variety of fuels may be used. Such an engine has been operated at the Point of Ayr colliery and an important application at the present time is in the generation of power at sewage plants where sewage sludge gas is available.

Carbonisation & Coke Formation

D. T. Barritt and T. Kennaway¹⁹, after tracing the development of coke ovens to the present day, have discussed their inherent limitations including operational characteristics and the narrow range of coals which can be carbonised in them. They have considered the need for alternative processes to produce satisfactory coke from other coals and have given details of certain processes under development, namely the National Fuels process, the Brenstoff-Technik process and the Baumco process.

The results of experiments on the carbonisation of blends of Durham and Northumberland coals in Woodall-Duckham intermittent vertical chambers have been described by H. Bardgett²⁰ of the Fuel Research Station. Reserves of coals from which the highest grade of metallurgical coke is produced (viz., the 301 type with from 20-30 per cent volatile matter) are very limited. It has been shown that cokes

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produced in the intermittent vertical chambers compare closely in physical properties, other than size, with those produced in commercial ovens from similar coals. It has been shown that a weakly-caking high-volatile Northumberland coal can be blended with Durham coals, types 301, 401 and 501 to the extent of 50, 30-40 and 40 per cent respectively to produce coke of $2/1\frac{1}{2}$ shatter indices of 80/90 and of Cochrane index not below 74.

H. E. Blayden²¹ has given an account of some fundamental studies on coking coal and carbonisation carried out at the Northern Coke Research Laboratories, King's College, Newcastle-upon-Tyne. Work carried out in France upon coke formation and coal-blending has been reviewed by R. Cheradame²².

C. E. Marshall and A. Draycott²³ have studied the effects of atmospheric oxidation on the yields of the primary carbonisation products of certain Australian coals. The European Productivity Agency of OEEC²⁴ has recently issued a short paper entitled 'New Coking Processes.'

At the US Bureau of Mines, J. B. Gayle and E. L. Gulledge²⁵ have studied the relationship between coking time and the bulk density of coal in an experimental oven. The end of the carbonising process was precisely determined from time-temperature curves of thermocouples located in the middle of the charge.

Fundamental Work on Coal

Sir Charles Ellis²⁶ has discussed some aspects of coal pyrolysis and has included new information based upon work carried out at the Central Research Establishment of the National Coal Board.

He has pointed out that the changes which successively occur in coal when it is heated can be conveniently discussed in terms of four regions; pre-decomposition region up to about 300° C; decomposition region 300 to about 500° C; transformation region of semi-coke 550° to about 1,000° C and structure ordering in coke 1,000° to 3,000° C. In the decomposition region the kinetics of the reaction have been investigated by two different methods and a physical-chemical understanding of this stage seems possible. The course of events in each stage depends upon the detailed treatment in the preceding stage or stages.

A series of papers has appeared from the Central Laboratory of the Staatsmijnen in Limburg in the Netherlands. These papers by D. W. van Krevelen and his colleagues²⁷

deal with the chemical structure and properties of coal, namely (1) elementary composition and density, (2) reflectance, (3) molar refraction, (4) pore structure, (5) aromaticity and volatile matter, (6) calorific value and (7) elastic constants.

During the last few years work has been in progress in the Department of Mining of the University of Birmingham which has as its object the isolation and characterisation of intermediate humic acids (sub-humic acids) produced during the oxidation of coal. The first of a series of papers on the chemical constitution of coal has been published by A. E. W. Bailey, I. E. Kimberley and S. G. Ward²⁸.

Further interest has been shown in the infra-red spectra of coals and coal extracts. R. A. Friedel and M. G. Pelipetz²⁹ have compared the infra-red spectra of the anthraxylon constituents of bituminous coal with those of carbohydrate chars while J. R. Lakey and R. J. Sarjant³⁰ have reported the infra-red spectra of a range of coking and non-coking coals. It has been pointed out that low rank bright coals show evidence of a large proportion of aliphatic side chains and oxygen in the form of C=O groups. These features are less evident in high rank bright coals, which may have a more condensed structure.

Two papers on X-ray studies of the ultrafine structure of coals have been published by J. B. Nelson³¹.

C. E. Marshall³² has carried out a microscopic and chemical examination of samples of fusain (fusinite) and has reported upon its nature.

Further work on the coal hydrogenation process has been discussed by R. A. Glenn⁴². A. H. Billington³⁴ has pointed out that the smoke yield and the caking and swelling powers of coal can be greatly reduced by pre-treatment with oxides of nitrogen at temperatures below the decomposition temperature of the coal.

Peat as Fuel & Source of Chemicals

A Scottish Peat Committee set up in 1949 has published its report during the year²⁵. This provides a survey of the production and utilisation of peat and throws fresh light on the technological and economic problems involved.

In July an International Peat Symposium arranged by Bord na Mona was held in Dublin. Sixty-six papers were presented dealing with peat resources, methods of survey

of peat deposits, production of milled and sod peat, dehydration, application of peat in steam generation and in gas turbines, peat wax and the gasification of peat.

ACTIVITIES OF DSIR & RESEARCH ASSOCIATIONS

Fuel Research Station

Much of the work of the Fuel Research Board is connected with the avoidance of smoke and other substances causing air pollution. During 1954, the Report of the Fuel Research Board with the Report of the Director of Fuel Research for the year 1953 was published36, Mention is made of the extending use in industry of Fuel Research Station smoke eliminator doors for handfired natural-draught boilers and work is reported on other types of boiler. A method of washing flue gases with ammonia in order to remove sulphur compounds is being studied at the Fuel Research Station and fundamental work on this problem is assisting the work.

Factors causing the production of smoke from open fires have been studied and improved methods of recording the amount of smoke passing up domestic chimneys have been developed. Combustion chambers for coalfired gas turbines are under development. A 'straight through' chamber and a vortex chamber have been studied at the Fuel Research Station and effort has mainly been concentrated on developing a pressurised version of the 'straight through' chamber which is to be erected at the National Gas Turbine Establishment.

Studies on the synthesis of oils and chemicals by the Fischer-Tropsch process have been continued. Among other work, investigations on the production of metallurgical and domestic cokes by the carbonisation of coal and on processes for the gasification of low-grade coals have been carried out.

BCURA

The annual report for 1953 of the British Coal Utilisation Research Association³⁷ (Director-General, Dr. D. T. A. Townend) describes research into boiler operating conditions and a study of the burning of coal on boiler grates. A coking stoker has been substituted for the chain-grate stoker on which investigations have been concluded. Attention is also being directed to rendering gas producers less selective as to the type of coal on which they will operate efficiently.

Work has continued on a slagging cyclone

combustor for burning fine but not pulverised high-ash coal. A plant has been developed for pelleting slurries for feeding to a gas producer and a wide selection of colliery slurries has been used.

Progress has been made in studies into the constitution of coal by solvent extraction and examination of the infra-red spectra of extracts fractionated by chromatographic methods.

Other work includes the assessment of dust in combustion gases, studies on the combustion of coal volatiles, field and laboratory studies on boiler deposits and corrosion and studies to determine whether chemicals may be produced from coal.

Coal-Burning Gas Turbine for Locomotives

A considerable amount of experimental work has been in progress for some time in the laboratories of Bituminous Coal Research Inc., of Dunkirk, N.Y., on the development of a coal burning gas turbine suitable for use in a railway locomotive. Work done during 1953 has been summarised and more than 2,000 hours of operating experience with full-scale coal-fired gas turbines has been reviewed.

Sulphur: Removal and Recovery from Fuels

The problems arising from the occurrence of sulphur in fuels are many and serious. A conference organised by the Institute of Fuel dealing with these problems was held in London early in October³⁹. Papers were presented dealing with the social and industrial consequences of the presence of sulphur in fuels and with the effects of sulphur on iron production and in steel-making processes. Sulphur removal from fuel gases both by dry and wet methods was discussed. Selective quick washing of coke oven gas with ammonia was also considered and the operation of a Collin desulphurising plant was described.

Sulphur in oil fuel was considered and trends in the supply of and demand for sulphur in the UK were analysed.

General Fuel Economy

R. Walker¹⁰ has reviewed fuel economy in the chemical industry and D. C. Gunn¹¹ has considered the efficient generation of industrial steam. Some twenty industrial processes have been considered by S. J. Eardley¹², who has given particulars of the sources and forms of rejected waste heat from these processes. Examples are quoted where waste heat could be used with advantage to meet other heat requirements of the works.

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F. M. H. Taylor¹³ has considered the conservation of the nation's fuel and power resources.

Heat Pumps

An account of the heat pump installed by the Ministry of Fuel and Power at the Royal Festival Hall has been given by P. E. Montagnon and A. L. Rucklev44.

A domestic heat pump which will cool a larder to about 40°F and employ the heat removed to raise the temperature in a 30gallon insulated water tank to about 140° F has been put on the market.

Fuel Cells

A. M. Adams⁴⁵ has reviewed progress in fuel-cell research since the end of World War II, while F. T. Bacon46 has described research into the properties of the hydrogen-oxygen cell.

Solar Energy

Rising fuel costs and shortages have attracted attention to possible alternative sources of energy such as direct solar radiation. H. Heywood¹⁷ has described the solution of some of the technical problems involved in the application of solar-radiation to domestic water-heating and space-heating of buildings. A description is also given of experimental solar-heated houses designed in the US.

Combustion

In recent years the volume of published work upon different aspects of combustion research has been very great indeed. year under review is no exception. The Fifth International Symposium on Combustion was held in Pittsburgh from 30 August to 3 September, 1954, and 89 papers were presented in addition to 11 invited review papers on combustion problems.

The contributed papers were grouped according to the following arrangement of topics; kinetics of combustion reactions, combustion of fuel droplets, propellant burning, combustion in engines, flame spectra, dissociation energies, special techniques, diffusion flames and carbon formation and the combustion of solids.

It is impossible to review these papers in the present article, but they are to be published in full quite soon in a similar form to those presented at the earlier combustion symposia.

During the year under review a volume has been published48 making available the proceedings of a combustion colloquium held at Cambridge University in December, 1953, under the auspices of the Advisory Group for Aeronautical Research and Development of NATO. The 18 papers are grouped into four sections: Laminar flame propagation. turbulent combustion, solid and liquid propellants and technical combustion problems.

Fuel Testing

The third meeting of the Technical Committee of the International Standards Organisation was held in London in November, 1953. to deal with coal analysis. Draft recommendations on certain analytical methods were approved. J. G. King¹⁹ has discussed the standardisation of methods of analysis of coal and coke.

R. A. Mott and W. C. Thomas 50 have studied the determination of calorific value of solid fuels, while J. E. Barker and R. A. Mott⁵¹ have studied the determination for liquid fuels.

The accurate determination of moisture in coals has been studied by J. B. Goodman. M. Gomez and V. F. Parry, at the US Bureau of Mines52.

T. Batty, R. Johnson and H. C. Wilkinson² have pointed out that in the determination of sulphur by the Eschka method, provided a temperature of 700°C is reached the use of bromine water (to oxidise any sulphites to sulphates) is unnecessary. The volatilisation of germanium during the ashing of coal has been studied by K. V. Aubrey and K. W. Payne54.

E. Bonaugri⁵⁵ has investigated the miscibility curves at different temperatures of some ternary systems including paraffins, naphthenes and aniline. An equation is proposed whereby the amount of naphthene present can be determined.

T. Bispham and F. R. Weston⁵⁶ have studied the nature of the volatile matter in coke. D. McNeil and G. A. Vaughan⁵⁷ have developed an assay method for primary distillation, treatment of the light, medium and heavy oils and of the tar acids and bases of coal tar. Twelve representative British tars and one Lurgi tar have been examined.

The above review is not intended to be comprehensive but merely a survey of some of the developments which have taken place in fuel technology over a period extending roughly from Autumn, 1953 to Autumn, 1954.

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The new metallurgical building at NPL, officially opened by Sir Lawrence Bragg on 6 April





General view of the new units installed at the Radio-chemical Centre, Amersham, which were opened by Sir Henry Dale, O.M., on 8 April. These are the first in the country to be specially designed for the accommodation of isotope production processes

American Sulphur

Enough to Meet All Needs

THE US sulphur industry broke all past production records in 1954 and begins the new year with sufficient productive capacity to satisfy all demands upon it. both domestic and export. This report was made by Charles A. Wight, chairman of the executive committee of Freeport Sulphur Company, in a year-end review of the industry. Freeport is a major producer and exporter of crude sulphur.

Mr. Wight estimated that US production of sulphur from all sources in 1954 reached 6,600,000 long tons, or 350,000 tons more than in 1953. Most of this production came from the salt dome deposits in Louisiana and Texas mined by the Frasch hot-water process.

'Productive capacity is now at an all-time high,' Mr. Wight said. 'It is ample to meet all demands of consumers here and abroad.'

The UK, which depends upon the US to fill about a third of her sulphur needs, imported about 400,000 long tons in 1954, or approximately 200,000 tons more than in 1953.

The estimate of 6,600,000 long tons of sulphur produced in 1954 is based on preliminary figures. Of the total an estimated 5,450,000 tons was Frasch process sulphur, 350,000 tons was sulphur recovered from

gases, 400,000 tons was sulphur contained in pyrites, and 400,000 tons was sulphur in various forms from other sources.

Output of Frasch sulphur was about 300,000 tons more than in the previous year. The gain was made possible by the successful operation of Garden Island Bay, Freeport's new mine at the mouth of the Mississippi. This \$14,000,000 mining plant, completed late in 1953, produced more than 500,000 tons in 1954.

Output of non-Frasch sulphur increased about 50,000 tons over the previous year. A total of ten projects for recovery of sulphur from sour natural gas and refinery gases and for production of sulphur in various other forms went into production or neared completion in 1954.

As the new year begins, efforts to add further to the sulphur supply are continuing. These include a new Frasch project at Chacahoula dome in Louisiana and eight other projects of various types.

Contract for Mill Expansion

A \$15,000,000 contract for expansion of the Canadian International Paper Company's mill at La Tuque, Que., has been awarded to the Foundation Company of Canada Ltd. The building programme includes increasing the capacity of the chemical recovery system.

Some New Reagents in Analytical Chemistry

OVER the past two or three years notable progress has been made in the development of new reagents. As is to be expected, only time can show the real value of these developments, because a new reagent cannot be assessed adequately until it has been tried out under a variety of conditions. Nevertheless, it is often possible to judge, from the published information, the advantages and shortcomings of a particular reagent when applied to a

particular problem.

One unfortunate obstacle to the ready adoption and application of new reagents is that most suppliers are unwilling to synthesise a product which offers preparative difficulties until there is an assured market for it. And as there cannot be an assured market until the reagent has been widely used, the position remains static until some research worker, probably with inadequate facilities for synthesis, has to prepare the reagent in the hope of solving a particular problem of his own. This often accounts for a new reagent only coming into use some years after first being advocated.

Diammine Tetrathiocyanato-Chromium(III)

The above reagent (Reinecke's salt) was first used by Mahr and Ohle1 to separate cadmium from zinc. In the presence of thiourea an insoluble cadmium complex is formed containing only 12.47 per cent of cadmium. Recently Rulfs, Przbylowicz and Skinner² have examined the method and the nature of the complex formed. As a result of this examination they recommend the reagent for the determination of cadmium because it has many advantages.

Interferences are few and are as follows: lead, antimony, copper, mercury, tin and bismuth. Lead can be removed as sulphate; antimony, which interferes owing to hydrolysis, can be held up with tartrate; and bismuth can be removed as bismuthyl iodide. Mercury and copper can be separated by treating with Reinecke's salt alone; cadmium does not precipitate in the absence of thiourea and may be determined in the filtrate3.

The most remarkable feature of the method is that as little as 0.03 mg. of cadmium may be separated from up to 20,000 parts of zinc by a single precipitation. The procedure is as follows:

Adjust the solution to 0.1-1.0 N in sulphuric or hydrochloric acids. Add freshly-prepared and filtered 5 per cent thiourea solution to bring the concentration of the sample solution to 1 per cent. Add a saturated solution of Reinecke's salt which is 1 per cent in thiourea. Stand in an ice-bath for 30 minutes (for 60 minutes if Cd <1 mg.). Filter with suction, wash once with cold 1 per cent thiourea and 3-4 times with cold ethanol. Dry for 1 hour at 110°-120° C.

Dicyclohexyl-Thallium(III)

Several di-organo-thallium(III) compounds have been examined by Hartmann and Bäthge4 as precipitants for the nitrate ion, and the di-cyclo-hexyl derivative was found to be the most suitable. This forms a soluble sulphate, perchlorate and acetate, all of which may be used as reagents. The precipitate is so insoluble that it may be washed without loss. It is more readily filtered than nitron nitrate.

The determination is completed either gravimetrically or titrimetrically; two titrimetric procedures are recommended. one the nitrate solution is titrated with reagent to the flocculation point; in the other method the excess thallium is precipitated with oxalate and the remainder titrated with permanganate. The precipitate may, of course, be decomposed with fuming nitric acid and the thallium determined by a standard procedure.

The reagent is stored as the carbonate and dissolved in sulphuric, perchloric or acetic acid before use. Sulphuric acid is normally used, but if there are interferences, acetic acid should be substituted.

For gravimetric determination the reagent should be dissolved in sufficient acid so there is one mole of acid in excess per mole of salt; the thallium complex is more soluble under these conditions and the complex nitrate crystallises out much better than from neutral solution. The solution should only be neutral for the oxalate-permanganate method or if fluoride is

In neutral solution the following ions interfere: C1', Br', I', CN', CNO', CNS', Fe(CN)6", Fe(CN)6", CO3", C2O4", C4H6O6",

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on of Combeen ny of amme f the S", SO3", NO2', CrO4" and MnO4'. The last only gives a precipitate in dilute solution: at higher concentration it is reduced to MnOa.

In strong acid solution, pH 0-1, the ions CO3", CrO4", C4H6O6", SO3" NO2', CrO4" and MnO4 do not give precipitates. Most of the remaining ions can be removed by precipitation with silver fluoride or acetate.

To prepare the reagent treat a 0.1M ethereal solution of thallic chloride with an approximately 0.3M Grignard solution of cyclohexyl chloride and magnesium in ether. To the resulting mixture of thallous chloride and di-cyclohexyl-thallium(III) chloride add excess of silver fluoride or acetate acidified with sulphuric acid. Precipitate the excess with hydrogen sulphide. Boil the filtrate to expel hydrogen sulphide and add sodium carbonate. Filter and wash with water until the washings no longer give the reaction for thallium with iodide. Dissolve the complex in sulphuric acid, reprecipitate as the carbonate and repeat the treatment. Dry at 105° C.

Purity Check

The purity may be checked by boiling 1 g. of the carbonate with 10 ml. of 50 per cent acetic acid, until no more carbon dioxide is evolved, and diluting the solution to 100 ml. with water. Only pure white precipitates should be formed with hydrogen sulphide or potassium iodide. Silver or barium acetate should give no precipitate at all.

To apply the gravimetric procedure bring the solution to boiling (50-100 ml. containing 50-100 mg. of nitrate). Add 50-100 ml. of 0.05M reagent (the carbonate dissolved in dilute sulphuric or acetic acids) and cool to room temperature. Filter through a sintered glass crucible (G.3) avoiding, as far as possible, sucking the precipitate dry. Wash 2-5 times with 10 ml. of ice-cold water and dry at a temperature not exceeding 150° C. Weigh as C10H20TINO3, MW 432.694. The factor for HNO₃ is 0.1456, that for NO₃, 0.1433.

A correction for the small amount of precipitate which is washed away is made by washing until the filtrate is no longer turned cloudy by chloride ions. The total volume of filtrate and washings is measured in ml. and divided by 150; 150 ml. of water dissolve I mg. of precipitate. The result in mg. is added to the weight obtained.

In the titrimetric method, cations which give precipitates with oxalates must be absent. Boil the solution and add exactly 100 ml. of 0.05N reagent solution. Cool, add 50 ml. of 0.1N oxalic acid and filter both precipitates off together. Wash as before, acidify the filtrate with sulphuric acid and titrate the excess oxalate with 0.1N permanganate. Since the reagent and oxalic acid added are equivalent, the permanganate consumed corresponds to the NO, present.

One ml. of 0.1N KMnO₄ = 6.3015 mg, of HNO₃ = 6. 2008 mg. of NO₃. It is advisable to run a blank because of the instability of the reagent. The difference in titres then corresponds to the NO3' content.

Alizarin Blue

Alizarin blue has been shown by Feigl⁵ to be a specific reagent for bivalent copper ions. In strongly acid solutions, only copper forms a precipitate with a pyridine solution of the reagent. In ammoniacal solution zinc, cadmium and nickel vield precipitates which dissolve in acids. The complex is not decomposed by sulphide or cyanide ions, as is usual with most other copper complexes which are insoluble in water.

The main obstacle to developing a gravimetric method lay in the fact that the reagent is only soluble in pyridine to the extent of 0.2 per cent. Accordingly, when the pyridine solution is added to an acid solution containing bivalent copper, the reagent is also precipitated. However, when the contaminated precipitate is treated first with acetic anhydride and then with pyridine, the reagent is completely removed whereas the copper complex remains unaltered; no occlusion of the reagent occurs at all. The solubility of the dye is thought to be due to an acetylation of the phenolic groups, because the solution does not react with bivalent copper, but when evaporated and treated with pyridine the reactivity is re-established. Because of the voluminous nature of the precipitate the amount of copper present should not exceed

When the reagent is added to a solution of cuprous cyanide the complex cupric compound is formed. The system:

 $Cu_2(CN)_2 \rightleftharpoons Cu_2^{++} + 2CN'$(1) undergoes autoxidation thus:

 $Cu_2^{++} + O + 2H^{+} \rightarrow 2Cu^{++} + H_2O...(2)$ The Cu++ ions formed in (2) react with the reagent, disturbing the equilibrium (1), which is immediately re-established. In this way all the cuprous cyanide is transformed into the complex compound. Cuprous cyanide is produced from solutions containing complex cyano-cuprous ions by adding formaldehyde. tates

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The procedure is as follows: Add 20 ml. of 6N sulphuric acid to 20 ml. of an aqueous solution containing not more than 2 mg. of copper. Heat the solution and add the reagent slowly. The reaction is slow at first, but once initiated it continues rapidly. When precipitation is complete, the supernatant solution must be reddish-blue and distinctly acid. Allow to stand 30-60 min. and filter on a fine sintered glass crucible using 3N sulphuric acid to effect the transfer.

Place the crucible in a small beaker filled to half the height of the crucible with acetic anhydride, cover the beaker with a clock-glass, and heat to 60-80° C for 30 min. Filter the acetic anhydride from the crucible and wash with hot pyridine until the filtrate is no longer blue. Wash with ethanol, dry at 100° C for 30 min. and weigh. The weight of the precipitate in mg. × 0.0991 = mg. of copper present.

In the presence of cyanide proceed as follows. To the solution containing not more than 2 mg. of copper, as the complex cyano-cuprous anion, in a volume of 20 ml., add a few drops of formaldehyde. Acidify with 20 ml. of 6N sulphuric acid and heat to boiling to expel excess formaldehyde; then proceed as before.

Four reagents are required including a saturated solution of alizarin blue in pyridine; the stable solution is obtained by dissolving an excess of reagent in hot pyridine and filtering after cooling to room temperature. Acetic anhydride, pyridine and formaldehyde are also necessary.

1,2,3-Benzotriazole

The above compound was first suggested as a precipitant for silver by Remington and Moyer in 1937⁶. Copper, cadmium, iron(II), nickel, cobalt and zinc are also precipitated. Curtis⁷ has recommended the reagent for the determination of copper in steel. The poor selectivity of the reagent has restricted its general application.

It has been found recently by Cheng⁸ that in the presence of ethylenediamine tetra-acetic acid only the silver salt of 1,2,3-benzotriazole is precipitated. Hence under such conditions the reagent is virtually specific for silver. A gravimetric and a titrimetric procedure have been developed; in the latter method the precipitate is dissolved in an excess of standard cyanide and titrated according to the Liebig-Déniges method.

The recommended procedures are as follows: Add 1-10 g. of disodium ethylenediamine tetra-acetate (according to the amount of other metals present and which require to be

masked) to the solution containing 10-110 mg. of silver. Adjust the solution to neutrality or slight acidity, using nitric acid or ammonia and heat to 60°-90° C. Add a slight excess of reagent (2.5 g. dissolved in 30 ml. of concentrated ammonia and diluted to 100 ml. with water). For 10-110 mg. 10 ml. are suitable, Digest at 60° C for 15 minutes and cool to room temperature. Filter through a medium porosity filter, wash 5 or 6 times with 10 ml. of water and dry at 110° C for 1-2 hours to constant weight. The conversion factor is 0.4774.

Alternatively, dissolve the precipitate in 10 ml. of 1:1 nitric acid, dilute to 50 ml. with water and make the solution alkaline with ammonia. Add a measured quantity of 0.05M cyanide solution and back-titrate with standard silver nitrate solution using 1 ml. of 2 per cent potassium iodide solution as indicator.

Benzilic Acid

Benzilic acid has been examined as a precipitant for zirconium by Klingenberg, Vlannes and Mendel⁹. They found that precipitation became more incomplete as the acidity was increased, but this effect could be counteracted by increasing the amount of precipitant. When 15 ml. of concentrated hydrochloric acid were present for each 150 ml. of solution, good results were obtained by using 100 ml. of a 2 per cent solution of reagent. As the acidity was increased, interference by foreign ions was reduced. When the method was applied to steels, good results were obtained.

An attempt was made to weigh the zirconium benzilate precipitate directly, but reproducible results could not be obtained. It was necessary, therefore, to ignite to the oxide. The precipitate was found to be readily filterable and easily washed. The reagent is particularly recommended for the determination of small amounts of zirconium.

Sodium Tetraphenylboron

This compound, now called by the trivial name of Kalignost, was first prepared by Wittig and his co-workers in 1949¹⁰. Since it was found to possess a sparingly soluble potassium salt, Raff and Brotz¹¹ examined its analytical properties in 1951 and recommended it for the determination of potassium. Since that period an enormous literature on the subject has developed. It has been reviewed recently by Nutten¹².

The method using Kalignost is the best yet

advanced for the determination of potassium. It is rapid, accurate and selective, and has already been applied to a number of commercial materials.

Although the gravimetric method is generally preferred, several titrimetric methods have been advanced, and the best of these appears to be that described by Flaschka, Holasek and Amin¹³. In this method, the precipitate is dissolved in acetone and treated with mercuric chloride which reacts as follows:

 $KBPh_4 + 4HgCl_2 + 3H_2O \rightarrow 4PhHgCl$

+ 3HC1 + KC1 + H₃BO₃ The liberated acid may then be titrated with

alkali.

The most extensive study of the reagent to

The most extensive study of the reagent to date is that made by Kohler¹⁴. His conclusions are as follows:

- (1) It is better to precipitate at room temperature.
- (2) The best medium is 0.1N mineral acid.
- (3) For accurate work the reagent must be pure.
- (4) The precipitate is more soluble than was originally believed,
- (5) Ammonium salts need not be fumed off but can be precipitated along with the potassium and the two ions determined by the one precipitation. The ammonium ion can then be determined by other means.

There is no doubt the discovery of this reagent has solved one of the oldest problems in analytical chemistry and it is to be expected that it will soon become firmly established as the most satisfactory reagent for the determination of potassium.

2-(o-Hydroxphenyl)-benzoxazole

The above reagent has been found by Walter and Freiser¹⁷ to be more selective for cadmium than any reagent previously recommended. The average error for the range 1-80 mg, is only 0.3 mg. In a tartrate medium at a pH of 10.5 nearly all interferences are eliminated. Copper is precipitated but may be removed by prior precipitation at a lower pH. Nickel and cobalt interfere when in excess of 20 mg., but can be removed by prior precipitation with dimethylglyoxime and 1-nitroso-2-naphthol. A very favourable gravimetric factor, 0.2109, is obtained.

The procedure is as follows; Add 3 g. of ammonium tartrate to the solution and heat to 60° C. If calcium is present a precipitate will form; filter this off, and add a further grain of ammonium tartrate to the filtrate.

Add a freshly prepared 1 per cent alcoholic solution of reagent, allowing a slight excess for precipitation of cobalt, nickel and copper. Adjust to pH 4 with 3N sodium acetate solution. Digest for 15 minutes at 60°C, cool and filter and wash. The precipitate is the copper complex. If nickel and cobalt exceed 20 mg., remove as indicated earlier.

Add to the filtrate 1N sodium hydroxide solution until a pH of 9 is reached and heat to 60° C. Add a slight excess of reagent and adjust the pH to 11. Digest at 60° C for 15 minutes, cool, filter and wash with 1:1 alcohol. Dry at 130°-140° C to constant weight.

2-(o-Hydroxyphenyl)-benzimidazole

The same investigators¹⁸ also recommend this reagent for the determination of mercury. Over the range 10 to 85 mg. of mercury an average accuracy of 0.3 mg. was obtained. Interferences are remarkably few; of the common ions only ferrous and ferric iron have any effect. The recommended procedure is as follows:

Add 2 g. of sodium citrate, heat the solution to 60° C and adjust the pH to 5 with dilute caustic soda or acetic acid. Add a slight excess of a 1 per cent alcoholic solution of the reagent and bring the pH to 6.5 with 0.3N sodium hydroxide solution. Digest the precipitate at 60° C for 15 minutes and allow to cool to room temperature. Filter on a sintered glass filter and wash with 1:1 alcohol solution. Dry at 130°-140° C to constant weight. The gravimetric factor is 0.3230. A volumetric finish may be applied if desired, based on bromination. A favourable factor is obtained in this case as well.

Nitroso-2-fluorenyl-hydroxylamine

Oesper and Fulmer¹⁹ have examined the analytical properties of the 2-fluorenyl analogue of cupferron. It forms precipitates with many metal ions, those with iron(III), antimony, cobalt and lead being readily soluble in chloroform. The quantitative applications of the reagent were examined as regards the determination of iron following the procedure used with neocupferron, employing a saturated methanolic solution. As little as 5 ppm. could be determined successfully, which is similar to the amounts which can be determined using neocupferron. Large amounts of calcium, manganese, nickel, cobalt, zinc, chromium, mercurv(I), aluminium, cadmium or arsenic (III) did not interfere with the determination. Copper interferes if present in amounts greater 155

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than the iron. The stability of the reagent was not examined.

N-Benzoylphenylhydroxylamine

This reagent was recommended by Shome20 as a reagent to replace cupferron. It precipitates copper, iron, aluminium and titanium quantitatively and in the first three cases the complex can be weighed as such. The solution is quite stable, as distinct from cupferron. More recently, Ryan and Lutwick21 have extended the use of this reagent to the determination of tin. The tin compound is different from those examined by Shome, in that it is an addition compound and not an inner complex compound. Its formula is always (C₁₃H₁₁O₂N)₂SnCl₂, regardless of the valency state of the tin in the original solution, for tin(IV) is always reduced by the compound to tin(II).

Ignition of the complex to the oxide, or weighing of the complex as such, gave good results. The latter method is recommended. Add 10 ml. of 11N hydrochloric acid to the tin solution and dilute to 200 ml. From a separatory funnel add dropwise with stirring 5 ml. of a 1 per cent solution in alcohol for each 10 mg. of tin present plus 8 ml. in excess. Cool in an ice-bath for 4 hours, filter on a crucible, wash with a few ml. of ice water and dry at 110° C. The conversion factor to Sn is 0.1927.

Tin was successfully determined in brass, and copper was precipitated from the filtrate as the complex by neutralising with ammonia.

Tetraphenylphosphonium & Tetraphenylstibonium Chlorides

These compounds were examined as analytical reagents by Willard and Perkins²². In general, the same ions are precipitated as with the well-established tetraphenylarsonium chloride. The phosphonium compound is more readily and more cheaply prepared than the arsonium compound. Tetraphenylphosphonium chloride is more soluble and tetraphenylstibonium chloride is less soluble than the arsonium chloride. The low solubility of tetraphenylstibonium chloride limits its use as an analytical reagent.

In most cases an excess of sodium chloride is essential to ensure complete precipitation, hence direct weighing is only possible in those cases where the precipitate is so insoluble that it can be washed with water. Titrimetric methods based on the addition of a known amount of the reagent, and titration of the excess by iodine to form the tri-iodide, may be

used. The precipitates are readily soluble in chloroform so that extraction methods can be applied where necessary. The interferences are similar to those obtained with tetraphenylarsonium chloride.

Mercury, tin and cadmium can be determined titrimetrically using the phosphonium compound. Perrhenate and perchlorate are determined both gravimetrically and titrimetrically. Although chlorate interferes in the perchlorate determination it can be readily removed by first reducing with sodium bisulphite. Perchlorate is also precipitated with the stibonium compound, but the procedure is not recommended because the solubility of the precipitant is so low. Periodate can be determined by precipitation as tetraphenylphosphonium periodate. Only the titrimetric finish can be used.

Both the stibonium and the phosphonium compounds form insoluble permanganates and a gravimetric finish can be employed in the case of this ion. The titrimetric method can be applied in the case of the phosphonium compound.

The alkali and alkaline earth metals, aluminium, manganese(II), chromium(III), nickel, cobalt, zirconium, sulphate, borate, phosphate, carbonate, acetate, phosphate and citrate do not interfere. The following ions precipitate either partially or completely: permanganate, perrhenate, periodate, perchlorate, persulphate, borofluoride, chromate, molybdate, tungstate, thiocyanate, iodide, tin(IV), cadmium, zinc, platinum, iron(III), gold, antimony, bismuth, titanium, thallium(III), tellurium and uranium. The interference of tin can be eliminated by tartaric acid, that of iron by orthophosphoric acid and of titanium by metaphosphoric acid. The effect of copper in the iodine titration can be eliminated by the addition of citrate.

4-Chloro-4'-aminodiphenyl

Two new organic reagents for the precipitation of the sulphate ion have been developed, 4,4'-diaminotolane¹³ and 4-chloro-4'-aminodiphenyl²⁴. Although the sulphate of the former is less soluble (52 mg. per litre) than that of benzidine (98 mg. per litre), that of the latter is considerably less so (15 mg. per litre), and hence it has a decided advantage. Using 4-chloro-4'-aminodiphenyl it was possible to determine sulphate satisfactorily down to about 1 mg. In a recent application of the method as little as 30 μg. of sulphur could be determined²⁵.

In the general method the amine sulphate is filtered off and washed and the hydrosulphate is titrated with standard alkali. Two procedures are advocated according to the amount of sulphate present. They are as follows:

2.5-25 mg. of sulphate.—Treat the sulphate solution (1-10 ml.) with a small amount of filter-paper slurry and add sufficient of a 0.24 per cent solution of the hydrochloride to give a two-fold excess. Allow to stand for 15-20 minutes.

25-100 mg. of sulphate.-Proceed as above (but the volume of solution may lie between 2-25 ml.) and add 0.48 per cent reagent heated to 40° C. Stand for 30 minutes.

Filter off the precipitates obtained by either method on a paper pulp pad, and use the filtrate to assist transference of the precipitate. Wash until free from chloride. Transfer the pad and precipitate back to the original flask, add water and break up the mass with a glass rod. Add 3-4 drops of mixed indicator (0.04 per cent phenol red: 0.04 per cent

bromothymol blue, 3:2), boil and titrate with standard alkali to a purple colour.

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Canadian Exports Boom

THE Canadian chemical industry reports that export business is reviving. Inquiries are coming from almost all the former trade countries and a few new ones as well, it is stated, and already they are paying off in mounting export orders. One of the largest Canadian chemical firms reports exports up 500 per cent in the past three months. Others estimate their gains ranging from 15 per cent to 200 per cent.

All companies look to 1955 as a banner export year. Basic chemicals, synthetic rubber, plastics, plastic raw materials and fertilisers are among some of the chief items affected.

The livelier export tune started to sound about September and has been picking up volume ever since. Most of it is resulting from the business boom in British Commonwealth and Western European countries, plus continued good business tempo in many South American countries.

Improving exchange positions are making the dollars easier to obtain by overseas importers. Import quotas are being continually relaxed to permit both a wider range of imported goods as well as larger quantities in individual categories, trade sources report.

Officials of Crown-owned Polymer Corporation, just back from a world market survey, said they see the overseas export outlook very promising. The change is particularly evident in the United Kingdom, New Zealand, Australia, France, West Germany, Benelux countries and Italy.

Shawinigan Chemicals Ltd. officials have noted a 'significant upturn' in the last three months, largely because of the improved exchange situation of sterling countries. They expect this business will get even better in 1955. Main countries involved were United Kingdom, Australia and New Zealand.

Biological Methods Group

AT the tenth annual general meeting of the Biological Methods Group of the Society for Analytical Chemistry held in the Meeting Room of the Chemical Society, Burlington House, London W.1, on 10 December. the following officers were elected for the forthcoming year: Chairman-DR. L. J. HARRIS, Ph.D., Sc.D., D.Sc., F.R.I.C.; Vice-Chairman-MR. K. L. SMITH; Hon. Secretary and Treasurer-MR. K. A. LEES.

Developments in Plant Protection

by KENNETH A. HASSALL, Ph.D., A.R.I.C. (Lecturer in Plant Protection, Reading University)

CROP protection has assumed great importance in recent years, and progress has been rapid. A conservative estimate of the loss of food due to all kinds of pest would be upwards of 15 per cent of the total potential harvest, weeds probably being responsible for more than half of this.

Plant protective materials include insecticides, fungicides and herbicides. Interest in insecticides became intense after the successful control of a typhus epidemic in Italy by DDT in 1944, and many chlorinated hydrocarbons were screened as potential insecticides. · Schrader's work on organophosphorus compounds became available after the war, and led to the introduction of insecticides with systemic action. New insecticides of both groups are still appearing, but the world shortage of sulphur stimulated a search for organic substances which could replace lime sulphur, the most important general fungicide.

Between about 1947 and 1951 several useful fungicides were introduced. Some of these, such as the glyoxalidines, contained no sulphur, while others, such as sulphenamides and dithiocarbamates, used sulphur more economically in terms of lb. per acre. The value of many of these new fungicides under British conditions is still uncertain, and, though of considerable interest, their relative merits cannot be reliably assessed at the moment.

Switch of Emphasis

During the last few years, the emphasis in the bulk of published work has switched to herbicides. Naturally, many important advances in this field occurred many years ago. Templeman's work on plant growth substances in 1930 initiated the use of hormone-type weedkillers, but it is only fairly recently that they have been employed for large scale weed control.

The hormone-type and nitroalkylphenol herbicides control broad-leaved weeds among monocotyledons, and the necessity for the control of grasses in broadleaved plants led to the development of carbamate and urea derivatives. A few chemicals used for plant protection have been chosen for discussion

below, since there are far too many for details of each to be given in a brief account.

INSECTICIDES

Chlorinated Hydrocarbons

The initial screening of substances for plant protection has been largely empirical and is likely to remain so for many years. But once a useful compound has been found, systematic synthesis of related compounds has often proved very rewarding. The remarkable success of DDT (p,p'-dichloro-diphenyl-trichloroethane) led to the synthesis of numerous closely related compounds in an attempt to discover more active ones, or alternatively, to find materials toxic to a different range of insects. Studies of the comparative toxicities of related compounds also often enable various theories of the mode of action to be examined.

Of particular importance in this latter connection has been the preparation of isosteres of DDT. Woodcock1 tested a series of DDT analogues in which the five chlorine atoms were successively replaced by methyl groups. The pentamethyl compound (a hydrocarbon) was non-toxic, though some toxicity was observed when as many as four methyl groups had replaced chlorine. This is of interest since the pentamethyl compound has been reported by Blinn2 to be as toxic to mosquito larvae as DDT. If this were confirmed, the existence of an insecticidal hydrocarbon as toxic as DDT itself would require considerable revision of certain of the theories of action of DDT, especially that relating to dehydrochlorination. Woodcock refers to some of these theories, including the recent 'trihedralisation' theory, in terms of which he proposes to review the work on isosteres.

The studies at Rothamsted of McIntosha indicate difficulties which are likely to be met whenever attempts are made to determine relative toxicities of insoluble substances. It is difficult to formulate any two such substances in precisely the same way, and large crystals tend to be retained by an insect cuticle much more readily than small ones. This is a purely mechanical effect,

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and not a function of molecular structure. Even when substances are considered under comparable conditions of crystal shape and size, the observed toxicities are not necessarily related in a simple way to chemical reactivity or molecular shape. The speed of solution of crystals in the outermost layer of the insect cuticle appears to be of great importance, and such physical properties as this cannot easily be related to the molecular sizes or shapes of analogues. Generally speaking, factors of this sort have seldom been taken into account when comparisons of toxicity have been made, and it is not surprising that a simple relationship between constitution and toxicity has not been observed.

It should be noted that these difficulties are additional to those applying to comparisons of substances administered in aqueous solutions or as fumigants. Even for these the external toxic concentration is determined not only by the speed of reaction of the insecticide with the vital component at the site of action within the insect, but also by the different phase distributions of the various compounds between the external medium and this site of action.

The success of dichlorobenzene, DDT and BHC (benzene hexachloride) stimulated a wide study of other chlorinated aromatic compounds. Among the substances which were found to be promising were aldrin (I), dieldrin (II), chlordane (III) and a chlorinated camphene called toxaphene. new compounds have advantages over DDT for certain purposes, although they do not possess its all-round usefulness. differ in their stability, volatility, and to some extent in the range of insects they will control. Aldrin has an appreciable vapour pressure, and is particularly recommended for use against soil organisms such as cutworms, leatherjackets and wireworms. Dieldrin has a lower vapour pressure, and so is more valuable as an aqueous spray suspension.

Chlordane differs from the other chlorinated hydrocarbons mentioned here in being a liquid. It has been tested extensively in America, but has been little used in Britain. perhaps because of the possible danger to mammals (Lehman4). BHC, discovered in 1942, is still used extensively. It has long been known that the y-isomer is far more toxic than α , β and δ isomers, and more recently Backs reported that the e and n isomers were also not insecticidal. Impurities associated with the visomer are responsible for the tainting of root crops grown in soil to which BHC is applied, but in recent years pure y-BHC has become available commercially, and is an improvement welcomed particularly by the horticulturist, Pure y-BHC has been given the name lin-

Apart from the fact that all the potent chlorinated hydrocarbon insecticides will control a rather similar range of insects, the group as a whole has several important limitations. Many of them, and especially DDT, induce the development of resistant races of insects, while beneficial insects are frequently harmed by them. Thus where an insecticide has induced the development of a resistant race of a pest, and also eliminated its natural predators, the result is often a build-up of the harmful insect far exceeding what would have occurred if the natural balance had not been disturbed.

Another difficulty may occur: pests which are not true insects and are not susceptible to insecticides may multiply as a result of the extermination of their insect competitors. The increase of red spider mite in many orchards where its natural predators like the black-kneed capsid bug have been killed off is an example of this.

Lastly, DDT and certain other chlorinated hydrocarbons are phytotoxic to members of the *Cucurbitaceae*. A need therefore exists for other compounds which can be used when for one reason or another the chlorinated hydrocarbons are unsatisfactory.

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memthereh can er the ctory. In particular, since the latter are primarily effective against mandibulate insects, compounds which are more specific for sucking insects are needed. Schrader's work on organophosphorus compounds has led to the development of a group of substances with this property.

Organophosphorus Insecticides

At least three of the phosphorus compounds described by Schrader are now well known as insecticides. These are TEPP (tetraethyl pyrophosphate), parathion (IV) and schradan (V); many others have since been investigated. TEPP is a water soluble liquid which is rapidly hydrolysed and has a contact but no protective action. It controls many soft-bodied insects, particularly aphids, against which it is more toxic than nicotine. Parathion is much more stable but is insoluble in water. Since it is relatively persistent, it has some protective action, but this in turn introduces the problem of the possible toxic hazard to the consumer. The rates of hydrolysis of this and some other phosphorus insecticides are reported by Coates". Parathion can pass through the leaf to the lower surface, so is useful to control aphis on low-growing plants such as strawberry.

Schradan differs from the previous compounds in that it is able to enter the plant and is carried around in the sap stream, so that parts of the plant not touched by spray droplets may become toxic to sap-sucking insects. Such a compound, and several are known, is termed a systemic poison. They are of great potential importance in that they persist within the plant, conferring protection from sucking insects, while they are not immediately available to mandibulate predators of such pests. They may therefore be expected to alter the biological balance in favour of the predator. Schradan is a viscous water-soluble liquid, stable when dry, and only slowly hydrolysed in aqueous solu-Ripper has described the chemical and biological properties of schradan and several other systemic insecticides.

Much recent work on systemic insecticides

has been done with the following objectives: to find out how they enter and move about in the plant; to determine the time of persistence within the plant and how they are eventually destroyed; and to determine the nature of the breakdown products. series of three papers, British workers' have reported that not all the schradan applied was absorbed, and that absorption was best through the cuticle of young leaves. Most travelled upwards, but a little was found below the site of application. A similar study has been carried out in America by Wedding using both schradan and systox (VI). He found that systox moved both up and down in the phloem at first, but later diffused into the xylem.

Considering its toxicity to insects, schradan itself is a rather weak cholinesterase inhibitor. Moreover, its persistence in the plant is far less than can be accounted for by its rate of hydrolysis (see Tew & Kirby¹⁰). Both lines of investigation lead to the conclusion that it is changed in the plant to a more potent anti-cholinesterase.

Casida et al.11 consider that schradan is oxidised in the plant to the monophosphoramide oxide of octamethyl pyrophosphoramide and the existence of an enzyme, phosphoramide oxidase, capable of effecting this conversion, has been postulated (see Casida & Stahmann¹²). Oxidation in this way, and also chlorination, increases the cholinesterase inhibitive power a millionfold, but renders the substance much less stable, and therefore less permanent in its action. The disagreement as to whether a cholinesterase or a general esterase in insects is the enzyme which is inactivated remains. Much of the recent evidence seems to support the general esterase suggestion, but the investigations of Roan and Maeda13 indicate that the enzyme is a rather specific one, for acetyl choline, but not β -methyl choline, is hydrolysed by it.

Many systemic and partly-systemic organophosphorus compounds are known, and almost without exception they are of the molecular type VII, where X is an acidic

Eto
$$S$$

$$P - O - CH_2 \cdot CH_2 - S - CH_2 \cdot CH_3$$

$$VI$$

$$R_1 \quad Y$$

$$R_2 \quad X$$

$$VII$$

group, Y is either oxygen or sulphur, and R1, R2 are either alkoxy- or substituted amino-groups. Dimefox $(R_1 = R_2 = di$ methylamine; X = fluorine; Y = oxygen) and mipafox $(R_1 = R_2 = isopropylamino;$ X = fluorine; Y = oxygen) are additional examples of such systemic compounds. Substances of this molecular type may be systemic if they possess sufficient water solubility to enable them to be translocated in the cell sap, but at the same time sufficient lipoid solubility to enable them to gain access to the cell sap through the waxy plant cuticle. Furthermore, they must be stable for a sufficiently long period of time to merit their use as protective poisons, yet, for food crops, not toxic to mammals when the plants are consumed.

Acaricides

It was mentioned above that certain insecticides were less toxic to the red spider mite than to their competitors and predators, and since the use of such compounds became widespread, the population of mites in orchards has in many cases increased alarmingly. Acaricides were therefore sought. The major problem is due to the fact that many generations are produced in one summer, and therefore a very small number of surviving winter eggs can give rise to a heavy infestation by harvest time.

Azobenzene was one of the first selectively acaricidal substances to be employed, and Eaton and Davies¹⁴ investigated the toxicity of numerous related substances. They found that the azo-group was not essential, but that two phenyl (or substituted phenyl) rings could be 'bridged' by other groups.

The acaricidal use of benzyl benzoate and DPS (diphenyl sulphone) was the immediate outcome of this work, but many others, including PCPBS (VIII) and chlorparacide (IX) are of related structure. It is of interest to

note that another line of research, aimed at producing DDT-like substances which were acaracidal, also led to the development of acaricides which could be regarded as being of the 'bridged' phenyl ring type, for example, DCPM (X).

It is rather too early to judge the relative value of these substances with certainty, but DPS, which is less persistent than PCPBS. and does not pass through the leaf, has been perhaps the least successful. On the other hand, it is more effective against adult mites than PCPBS, and if anything its phytotoxicity to fruit trees is rather less variable from season to season. PCPBS has caused defoliation or cracking of fruit on certain varieties of apples (for instances, see ref.") and it cannot be used on cucumbers or tomatoes. Both PCPBS and its p-chlorobenzene analogue (PCPPBS) differ from DPS in being primarily toxic to summer eggs rather than adults.

Chlorparacide is the most recent acaricide tried out on the large scale in Britain, and it appears to have given promising results. Like PCPBS it can pass through the leaf and control mites on the lower surface. It is far more effective against winter and summer eggs than it is against adults, but since it persists for about three weeks, it prevents the development of a new generation of mites after the existing adults have died off naturally.

HERBICIDES

The control of plants growing among other plants presents a task in many ways more formidable than those of controlling insects or fungi on crops. The physiological and often the morphological differences between weeds and crop plants which can be exploited to achieve selective control are limited. Nevertheless, selectivity can be obtained in several ways.

The simplest is probably that depending on the different times of emergence of certain crops and weeds from the soil, and especially the destruction of fast-growing weeds in slower-growing crops. Pre-emergence spraying can be carried out after the majority of the weeds have emerged, but before the crop seedlings approach within \$\frac{1}{2}\$ in. or so of the surface. Sulphuric acid was one of the first spray materials to be used as a pre-emergence herbicide and it is still employed for the control of weeds in onions. Many of the new urea and carbam-

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ate herbicides described below are also used for pre-emergence control. Some of the advantages and disadvantages of pre-emergence spraying have been mentioned by Roberts¹⁶ and conditions affecting pre-emergence weed control have been considered by Wolf¹⁷.

Differences in the morphology of plants may enable weeds to be controlled without damage to the crop. There is for example, a purely physical effect due to the tendency for rosettes of leaves to collect spray and to direct the droplets towards the central low growing point, whereas in Graminae the leaves are narrow and erect, and the growing point is well sheathed. Similarly, differences in cuticle thickness or degree of hairiness may be sufficient to produce a selective effect. Many of the compounds used to control dicotyledons growing among monocotyledons (e.g., inorganic and nitroalkylphenol herbicides) fall into this category, although physiological differences between the two types of plant are probably also important, especially for the hormone weedkillers.

Hormone Weedkillers

The hormone herbicides or growth-regulating substances are becoming increasingly important. They include 2,4-D (2,4-dichlorophenoxyacetic acid), MCPA (1methyl-4-chlorophenoxyacetic acid) and 2.4.5-T (the trichloro analogue of 2.4-D). although several others are known. have all been formulated in several ways, each formulation having advantages over the others in particular circumstances. 2.4-D is marketed as its sodium salt, which is more selective than its esters, but higher concentrations are necessary, and the action The triethanolamine salt combines to some extent the useful characteristics of the salt and ester. Nevertheless, the available hormone weedkillers are not always sufficiently selective; linseed and flax are easily damaged, also clovers in grassland. Methods have therefore been sought of increasing the safety of their use and the range of their selectivity. Three methods of achieving this are now known.

One of the main disadvantages of the earlier ester formulations was their volatility, which increased the hazard to nearby broadleaved crops as a result of vapour drift. The disadvantage has been largely removed by the preparation of esters of

much higher molecular weight. Polyethylene, butyoxethanol and capryl esters have been used in America.

Secondly, selectivity can be achieved by applying a solution of an innocuous substance to the soil, the substance being broken down within the soil to give a herbicidal product which then enters the plants via the SES, or 2(2-4-dichlorophenoxy)ethyl sulphate and SESIN, the corresponding benzoate, are used in this way. Vlitos18 reports that at least one type of soil microorganism is capable of effecting this decomposition, and that an enzyme may be responsible. For this kind of herbicide, the relative tolerance of the crop and weed depends not only on their actual resistance to the toxic substance, but also on the depth of the root systems, the shallower being more susceptible. These materials are of particular use in asparagus and strawberry beds, where the crop plants are easily damaged by foliar application of hormone weedkillers.

Thirdly, in theory it is possible to make use of variations in enzyme systems in different plants to achieve selective control. One interesting example of such a case has recently been reported by Wain and his Wye College Collaborators^{10,21}. It has long been suspected that plants can oxidise certain types of compounds by a mechanism similar to the β -oxidation well known in animals. Synerholm and Zimmerman²⁰ observed this for 2,4-D analogues in 1948, and Woodcock' noted a similar effect for naphthoxy n-alkyl carboxylic acids when tested by their power to induce parthenocarpy in tomatoes. Fawcett, Ingram and Wain²¹ showed chemi-

cally that this type of degradation did in fact occur in phenoxyalkyl compounds.

Homologues of 2,4-D can similarly be broken down in some plants by removal of carbon atoms two at a time, giving either 2.4-D or dichlorophenol according to the length of the carbon chain. Since the phenol is non-toxic, the propyl, amyl and heptyl homologues are also non-toxic, whereas the butyl and hexyl members of the series are. But the most important observation was that some crop plants damaged by 2,4-D itself were unable to bring about this oxidation, so that for such plants all 2,4-D homologues were non-toxic. Wain and his colleagues therefore considered that the butyl homologue of 2,4-D (2,4-DB) might be a valuable herbicide, possessing a higher degree of selectivity than 2,4-D itself. has been suggested22 that red and white clover and celery may be among the plants damaged by 2.4-D which may be unharmed by 2.4-DB at 2 lb, per acre.

It should be added that whether β -oxidation occurs or not depends greatly on the type of ring attached to the side-chain, and it has been found that some plants are capable of degrading one type or hormone homologue to its toxic analogue (e.g., 2,4-D), but are unable to oxidise another which has a different ring system (e.g., 2,4,5-T). This introduces the possibility of developing herbicides with even greater selectivity, though naturally the range of general usefulness of any one such substance would be much reduced.

New Herbicides

Many new herbicides have recently been studied, and of these, brief mention of the urea and carbamate types seems desirable. All the active herbicides of the urea group are asymmetrical derivatives like PDU (phenyl-dimethyl urea). CMU is the pchlorophenyl analogue of PDU. Both persist in the soil for months or even years after application, so that at high concentrations (40-80 lb. per acre) they can cause soil sterility for long periods. This persistence is of importance and has been much investigated. It has been found23 that urea compounds are highly adsorbed on to organic matter, and to a lesser extent on to clay particles, and persist longest in these soils.

On the other hand they act more quickly when less adsorbed, as in light soils. A much lower application rate is necessary for

selective control of weeds, especially when used as a pre-emergence spray; e.g., 1 lb. per acre is probably sufficient for weed control in beets (see ref.²⁴). The use of urea type herbicides as post-emergence sprays is not recommended at present. They appear to move downwards in the soil to a depth of about a foot, and so can control many deep-rooted perennials, but the land often cannot be used for a year or more afterwards.

Of the aryl carbamic esters, IPC (isopropyl-phenyl carbamate) and its p-chlorinated derivative, CIPC, have been most studied Like the urea derivatives, they kill both narrow-leaved and broad-leaved plants, but they have a greater monocotyledon selectivity and are thus in some measure complementary to the hormone and nitroalkylphenol herbicides. They are used primarily for the pre-emergence control of grassy weeds, but post-emergence control of chickweed has been successful. Crops such as peas, onions, beets, spinach and potatoes can tolerate up to about 20 lb. per acre. They are much less persistent than the urea derivatives, especially under warm climatic conditions. The monocot, dicot, selectivity ratio is clearly of great importance, and is so far little understood. George et al.25 have shown that high toxicity and high selectivity are not correlated in any obvious way with one another or with molecular structure. the toxicities of the ethyl and isopropy esters of chlorophenylcarbamic acid were high, and that of the n-butyl ester much lower, whereas, on a selectivity basis, the # butyl compound was by far the best.

FUNDAMENTAL RESEARCH

The lagging of fundamental research behind the practical use of plant protection chemicals is regrettable but inevitable. Far more knowledge is required about such physical and physiological differences between plants (or insects) as can be exploited to achieve selective control of weeds among crops, or destruction of insect pests but not More information is their predators. needed about the effects of molecular structure on toxicity, about the mode of action of different types of toxicant, and about the effect of formulation on effective toxicity. Small beginnings have already been made The auxin (or anti-auxin) nature of the hormone herbicides, the narcotic action of the carbamate derivatives, and the (cholin) esterase inhibition of the phosphorus comy when lb. per

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pounds are cases where the mode of action is at least partly understood.

In many cases the investigation of groups of closely-related substances for connections between toxicity and physical or chemical properties is a rather empirical process, but limited success has been achieved. Ferguson26 for example has shown that toxic materials which are narcotic often operate at nearly the same relative saturation of the external medium, despite the great differences in their absolute solubilities in that medium. It will be interesting to discover whether the carbamates conform to this rule when sufficient of them have been investigated. However, few plant protective poisons fall into this group. The alkyl chlorides and bromides usually act as narcotics, and have similar equitoxic relative saturations, but the closely related alkyl iodides do not (Hassall27), nor does methyl bromide, an economically important fumigant.

If the effect of molecular structure on toxicity is not understood for these relatively simple cases where specific steric effects (such as metabolite antagonism) are unlikely to be involved, it seems improbable that quantitative correlations between them will be forthcoming for the more complex substances used in plant protection and medicine. Finally, the work reported earlier on suspensions of DDT and its analogues should be a sobering reminder, to all who are concerned with the problem of relating toxicity to chemical constitution, of the many factors which can complicate their task,

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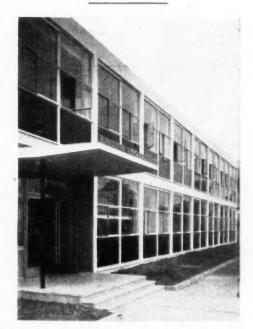
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New Expansion Plans for US Plant

Courtaulds (Alabama) Inc., the US subsidiary of Courtaulds Ltd., has decided to put in hand at once the second stage of expansion of its viscose rayon staple plant at Le Moyne, Alabama. Some months ago the company announced that it had decided to treble the capacity of the plant, from 50,000,000 lb. to 150,000,000 lb. a year, in two stages (THE CHEMICAL AGE, 1954, 71, 842). The first stage is now expected to be completed in the spring and the second by September.



Part of the office and laboratory block of British Visqueen Ltd., whose factory at Stevenage was opened during the year. This is the largest polythene manufacturing unit in the world outside the USA

Colouring Matters in Foods

Sub-Committee Report to Minister

THE Minister of Food has approved for publication a report presented to the Food Standards Committee by their Preservatives Sub-Committee, making recommendations about the use of colouring matters in foods. The main recommendation in the report, which has been endorsed by the Food Standards Committee, is that the Public Health (Preservatives, etc., in Food) Regulations, 1925-1953, should be amended so as to permit the use in foods of specified colours only. The present position under the Preservatives Regulations is that, with a few specified exceptions, the addition of any colouring matters to articles of food is permitted.

In the report, the sub-committee point out that the practice of colouring food is very old, and that it is generally accepted to be physiologically sound that food should be presented in as attractive a form as possible. Provided the colours have no deleterious effects on health the sub-committee see no objection to their use to replace natural colour lost during processing, to standardise appearance or to render a product more attractive. Since 1925, however, evidence has been accumulating which indicates that there are certain colours, in addition to those at present prohibited by the Preservatves Regulations, which may cause a risk to health if used in food.

New System Considered

The sub-committee have considered, in particular, whether the present system of control by means of a list of prohibited colours, should be continued or should be replaced by a list of permitted colours, what information in respect of the pharmacological action of colours is available, what colours should be prohibited and whether the addition of colour to any particular food or class of foods should be prohibited.

After consideration of the views submitted by various sections of the food industry and other interests concerned, the sub-committee have concluded that the introduction of a list of permitted colours for use in food, restricted to those which the available evidence indicates are unlikely to have harmful effects, would be in the best interests of health. A panel of the medical members of the sub-committee have examined the pharmacological evidence bearing on the colours (totalling 79) represented as being used in foods. A survey of 'coal tar' colours with special reference to the pharmacological aspect is contained in Appendix I to the report and the panel's findings are given in Appendix II.

Approved Colours

The sub-committee are of the opinion that any list of permitted colours should be compiled from those adjudged, on present evidence, to be unlikely to be harmful when consumed in foods in the customary amounts; and they recommend that, for the present, official approval should be given to 13 colours of natural origin and 32 synthetic colours, full particulars of which are given in Appendix III to the report. The sub-committee further recommend that the specified colours should be permitted to be used either singly or in any combination and that specifications of purity should be prescribed and published for each specified colour.

It is pointed out in the report that while it has not been possible to meet in full the stated requirements of the food trade, endeavour has been made to provide as wide a variety of colours as possible consistent with the need for the protection of the public health. In the light of any further evidency which may become available and provided there is a demonstrable need, colours may be added to, or deleted from, the list at any time.

The addition of colour to milk is already prohibited; the sub-committee recommend that a similar prohibition should apply to all natural products such as meat, game, poultry, fish, fruit and vegetables, sold in the raw or unprocessed state.

The sub-committee also recommend that, in general, notification of the presence in foods of added colour should be given to the purchaser, that colours sold for use in food should be appropriately labelled and that any regulations made as a result of their recommendations should apply also to imported foods.

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Working with a Polarograph

Interesting Papers at First Meeting of New Society

THE inaugural meeting of the Polarographic Society was held at 7.30 p.m. on 9 November in the Lecture Theatre of the Pharmaceutical Society, with Mr. W. J. Parker in the chair. The meeting was attended by over forty polarographers, who had travelled from all over England in order to be present. In referring to the enthusiastic support given to the new society by the 'polarographic profession,' the chairman stressed that membership was open to any person interested in the objects of the society, the annual subscription being only ten shillings.

The following papers were read:-

A Brief Introduction to Polarography by A. L. Glenn, F.P.S., Ph.D., Lecturer in Pharmaceutical Chemistry in the School of Pharmacy, University of London.

Polarography was a method of determining the concentration of substances, which would undergo some reaction at either the cathode or the anode of a small electrolytic cell. On occasions, it also allowed one to characterise the substance. Attention was focused on only one electrode of the cell (usually the cathode) and, experimentally, it was necessary to determine both the electrode potential and the current passing through it.

Basic Assumption

Provided one could assume that the cathode potential was linearly related to the EMF applied across the whole cell, the potential measuring circuit of the 'classical method' could be eliminated to produce a simple apparatus, which closely resembled the manual polarograph. However, the assumption was only justified if one controlled two experimental factors. In the first place, it was essential to use an anode of large surface area, for the anode obeys a similar law to the cathode in that its potential varies with the current passing. By comparing the current/potential curves of two electrodes of greatly different area, it was evident that for an anode of sufficient area, the potential could be regarded as virtually independent of the current.

Secondly, the voltage drop (IR drop) due to the resistance of the cell and galvanometer

should be kept as small as possible. In polarography, there were several advantages in using a dropping mercury electrode as the electrode to be studied, but it gave rise to the additional complication of residual current due to its continually increasing area.

The Polarograph with Derivative & Phase Selective Additions by G. L. Young, of the Research Department, Cambridge Instrument Co. Ltd.

The circuit of the DC polarograph was for convenience divided into three parts: the cell, the voltage supply to the cell and the current measuring or recording circuit. A linear potentiometer and a means of standardisation were an obvious requirement. In dealing with current measurement, the use of a reverse current as a null method in a direct reading instrument was mentioned together with the essential sensitivity, damping and zero controls. Counter current and compensating current controls were described.

'Previous Ions'

The improved resolution and ease of measurement associated with differential and derivative methods was discussed and the effect of 'previous ions' mentioned. functions of the phase sensitive ac polarograph attachment were as follows: (a) superimposition of a small fixed alternating potential on the direct potential from the slide wire, (b) selection of the in-phase current from the alternating current output from the cell, (c) rectification of the in-phase current for recording. The dynamic resistance and capacity effects at the dropping electrode were discussed as well as the way in which the capacity masks the resistance effect.

By using a phase sensitive rectifier, the capacity current could be eliminated, when a record like a derivative peak was obtained. The sensitivity of such a record was increased in relation to that of a Dc record, owing to the rapid transfer of material from solution to electrode and back again, when working at the half wave potential. The peak occurred at the half wave potential and its height was proportional to the concentra-

tion of reacting material. The effect of series resistance was mentioned together with a means of correcting for it. Finally, the advantages of the phase sensitive AC attachment with regard to resolution of close steps, effect of previous ion and increase in sensitivity, were enumerated.

Potential Pitfalls in Practical Polarography by Mrs. B. Lamb. B.Sc., Chief Chemist of Tinsley (Industrial Instruments) Ltd.

From the chemist's viewpoint, an explanation was given of the functions of the various parts of a modern recording polarograph together with an account of the more common misuses of the instrument. Attention was drawn to the fact that demands for greater accuracy and sensitivity were not always justified on analytical grounds, since chemicals of sufficient purity were still not in daily use in many laboratories. these conditions, available sensitivities were more than adequate. It was pointed out that with every increase in sensitivity, especially in the measurement of trace levels. residual currents due to minute quantities of depolarisers in the base electrolytes become more noticeable.

Calibration

Reasons were given for calibration by standard addition rather than by plotting calibration curves using synthetic solutions. In industrial analyses, where the basic materials are not always the same, the shape of the step tends to vary and therefore comparisons can be made with greater accuracy between two step heights of the same shape than by comparison of readings taken on two differently shaped steps. Compensation for high residual currents was discussed and the tendency to overcompensate in order to make an irreversible reaction appear reversible was noted.

Concerning maximum suppressors, the general empiricism, accepted even by workers of high repute, was challenged. In any new work or when working at high sensitivities (1 µamp full scale or less), great care should be exercised in the choice of the maximum suppressor, the concentration of which should be kept to a minimum. In conclusion, the instrument could only answer questions which had been correctly framed. It could not do the analyst's thinking for him. However, when correctly applied to a 'suitable problem, the answer could be

obtained rapidly, accurately and with a low subjective error.

The Application of Polarography to Pyrimidine Chemistry by Mrs. N. Luthy, B.S. M.A., Ph.D., of Stanford University, Stanford, California. (Working at the University of Manchester on a Grant from the British Empire Cancer Research Fund).

In an effort to enhance the cancer inhibiting properties already noted for certain naturally occurring purine and pyrimidine nucleotides, variously substituted pyrimidines have been synthesised.

In order to distinguish between pyrimidine 5-thiols, monosulphides or disulphides (R.SH, R.S.R. or R.S.S.R., where R is a 4-substituted uracil molecule) a rapid semimicro method of analysis was necessary to follow the course and products of a newly devised synthesis. Neither ultra-violet nor infrared absorption was of diagnostic value. The polarographic method was admirably suited for this purpose. In alkaline solution, only the —S—S— bond is reduced at the dropping mercury electrode. This made the assignment of formulae to the products of the reaction a much simpler task.

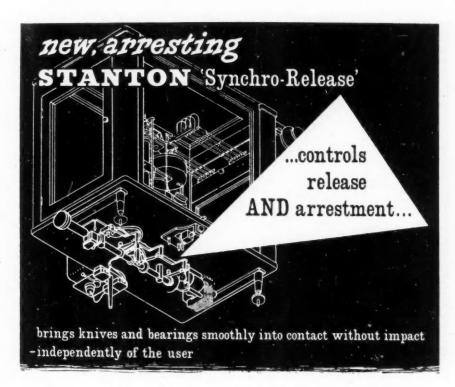
The relation of polarographic activity to physiological activity as well as to possible enol-keto structures of the tautomeric groups on the pyrimidine nucleus was also discussed.

Bid to Reach Potash Beds

POTASH Co. of America is preparing to sink a mine shaft at Patience Lake, about 15 miles east of Saskatoon, Saskatchewan. Canada. Freeze holes are being drilled to permit sinking the 3,000-ft, shaft through crumbling, sedimentary materials, and a large refrigeration plant will create a ring of ice around the shaft area to freeze off the water and solidify the materials.

The shaft will be the second attempt to tap Saskatchewan's potash reserves, estimated by provincial geologists to be the most extensive in the world. Western Potash Corp., a Calgary firm, has been sinking a shaft at Unity, Sask., since early this year and has now reached the 1,000-ft. level, about one-third of the way to the potash beds.

Potash Co. of America is carrying out its work under a lease agreement with the Saskatchewan Government, and expects 10 take from 18 months to two years.



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More Accidents in 1953

Annual Report of Chief Inspector of Factories

FOR the first time since the war there was an appreciable increase in industrial accidents during the year, says the annual report of the Chief Inspector of Factories (Sir George Barnett) for 1953. (Cmd. 9330 obtainable from HM Stationery Office or booksellers, price 6s. 6d., 6s. 10d. post free). Total number of accidents in 1953 was 181,637, compared with 177,510 in 1952, an increase of 2.33 per cent, but the number was still lower than in 1951. There was a decrease in the number of fatal accidents from 796 to 744.

The accident rate per thousand workers in factories only was 22.7, compared with 22.5 for 1952 and 23.4 for 1951, showing that accidents had increased more than proportionately to the working population, which reached a higher level than ever recorded in peacetime. The general picture, except in the metal trades in which there was a 7 per cent reduction in accidents, was of increased personnel and a somewhat more than proportional increased number of man hours worked.

In the chemical and allied trades the number of accidents rose from 7,649 to 7,757, an increase of 1.4 per cent, while the estimated numbers employed fell by 0.4 per cent.

More Electronic Apparatus

The report says that the development of electronic apparatus for industrial purposes had greatly increased in the last few years, accompanied by a spectacular improvement in quality and output. The safety aspect had kept pace with these developments and, despite the greatly increasing use, the accident rate had fallen.

Managements in industry generally had shown themselves fully alive to their responsibilities for the protection of workers against potentially dangerous radiations arising from the use of radioactive substances. Though the use of radioactive materials in industry continued to increase steadily, X-rays held their own. Rooms containing X-ray sets monitored by the Inspectorate were found to be protected to a standard well above the minimum necessary.

The report describes the protection of X-ray mobile sets for use where articles are too large, heavy or generally inconvenient to move to a central X-ray room. In one case a radiation pit was being constructed, the first of its kind in this country, the floor of which would be some twenty feet below factory floor level.

Use of Dosemeters

The use of personal pocket dosemeters for workers engaged regularly in gamma radiographic work was on the increase, and it was hoped that eventually all operatives would be so equipped as a matter of course, since these instruments enable 'on the spot' readings to be taken at any moment of the amount of gamma radiation absorbed by the body.

There was an encouraging response by manufacturers to the department's suggestion that containers and housings of radioactive substances should be distinguished by orange markings as an aid to easy identification and care in handling.

Progress in safety continued in the main on well-established lines. Foremost in importance came general improvement in the design of new machinery, both in safety and appearance, which was not only good in itself but had in many cases caused factory occupiers to realise the deficiencies of older machines and led to replacement or improved guarding.

Some firms of machine makers had not been so progressive and inspectors spent much time on educational work with them. In the case of complicated machines it was often very difficult for guards to be fitted later. Difficulty also arose from time to time with imported foreign-made machines which were not guarded to the standards expected in this country.

Charts in the report show the considerable decrease in the accident rate between 1937 and 1953 and also between 1949 and 1953, due very largely to accident prevention work, against a background of steadily increasing factory population.

An analysis of the accidents by age and sex shows that there was an increase (0.5 per

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More Accidents

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1,000) in the rate for women and girls, which was doubtless connected with the revival in the textile and clothing trades. Since 1949 the rates for adult women and girls had shown little reduction, which might reflect an increasing range of processes undertaken by women, with a correspondingly greater hazard—but this was unlikely to be the complete explanation.

Causes of Accidents

An analysis of causes discloses that the accident rate due to power-driven machinery decreased by 25 per cent between 1947 and 1953, against a decrease of 21.5 per cent for the total accident rate. The report states that as handling goods is still much the largest cause of accidents, there seemed justification for more and more mechanical handling.

There were 8,625 accidents to boys during 1953 and 3,346 accidents to girls, an increase on the 1952 figures of 20 (0.23 per cent) to boys and 188 (6 per cent) to girls. The accident rate for girls was higher than at any time since 1949, while the rate for boys approximately equalled the 1952 figure. The ratio of young persons' accidents to total accidents, round about 7.5 per cent, had shown no signs of diminution since 1949.

The Chief Inspector states that this is a real and pressing problem and reiterates a statement he made last year: 'Allowing young persons to be injured or killed is a form of extravagance in which British industry simply cannot afford indulge; the supply of juvenile labour which will be available during the next decade can be forecast accurately; it is well known that it will be inadequate and that no wastage can be made Young persons in fact constitute industry's most precious raw material, and employers would do well to ask themselves if they are watching over it with all the care that it needs.'

Examples are quoted of accidents to young persons in circumstances so deplorable that one questions whether certain employers are fit to be trusted with "this precious raw material". The report gives other examples, however, showing that the blame for young persons' accidents was by no means always to be laid at the door of management. These include illustrations of a num-

ber of accidents to both boys and girls caused by 'skylarking,' but many of these were due to lack of discipline and supervision.

The report says that much more could be done by older workers to set a good example, and to establish a good tradition. Boys were inveterate hero-worshippers, even in a factory, and had a great regard for 'Bill So-and-So—he's a smashing mechanic, the foreman gives him all the jobs no-one else can do,' and they would copy Bill's methods—working clothes, goggles and all.

A total of 12,846 accidents to workers aged 60 and over (12,334 men and 612 women) was reported. The net figures for factories only were 10,828 to men and 608 to women. The general impressions of inspectors are summed up in these words: 'Older persons in industry require a little privilege because of old age, which is so often accompanied by some infirmity. It would be helpful if they were allowed to leave the works a few minutes before the bulk of the workers in the large factories, so as to give them a better chance of getting to public transport without having to withstand the rough-and-tumble which is prevalent when numbers of persons leave some large factories. Other important points are to have their work place where much stair-climbing is not required and to keep shops especially tidy.'

Industrial Safety

Improvement and reorganisation of existing accident prevention organisations was the outstanding feature of reports from all over the country. Sometimes this had been under the regrettable stimulus of serious accidents and prosecutions, but gradually there had been achieved a great deal by progressive managements, keen safety officers, active works committees, and by the inspiration of the Royal Society for the Prevention of Accidents, especially in the various area groups.

An example cited is of a large chemical works employing about 600 workpeople which held an accident prevention exhibition for a week in one of their worksheds in the factory. There were also demonstrations of fire fighting and first aid and a safety talk was given. A trophy was awarded to the department with the best 'good housekeeping' and a prize given to the individual who made the best safety suggestion. Accident prevention literature was also distributed.

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More Accidents

continued from page 182]

The total number of eye accidents was 7,738, compared with 7,856 in 1952 and represented 4.26 per cent of all accidents. The concensus of opinion was that the most difficult problem in the whole field of eye protection was that of getting the individual to use the protection provided, whether statutorily or otherwise.

An analysis of the 425 accidents, including 20 fatal, due to inflammable liquids shows that the most common types of accident were those due to explosions caused by the application of heat by welding or cutting torches to vessels and plant which contained or had contained inflammable liquid (65, including two fatal); lighting or 'brightening' fires with inflammable liquid (57, including one fatal); leakages or spillages from containers or plant (48, including five fatal) and the use of inflammable liquids for cleaning purposes (44, including two fatal).

The largest number of accidents with acetylene is that due to the use of torches for we'ding, cutting and burning. Well over 100 of these are notified every year to the inspectors, an alarming proportion representing serious accidents. The number of accidents due to explosions from steam pressure vessels in 1953 was 83, four of the people involved sustaining fatal injuries. Explosions from air receivers and other vessels containing gases under pressure involved 169 people in accidents, of whom five died.

There was a slight decrease in the number

of cases of gassing compared with 1952–254 as against 265. Carbon monoxide accounted for 121 cases and chlorine 36. It is recommended that every gassing accident should be made the occasion of the reviewing of the rescue, resuscitation and first aid services and of all the circumstances of the occurrence.

Altogether there were 529 cases of industrial poisoning or disease, including 70 deaths. This compared with 470 cases (seven deaths) in 1952. Epitheliamatous ulceration or skin cancer (256, including 61 fatal) accounted for the highest number of cases, although this figure included 58 cases which only came to light on scrutiny of outstanding death certificates and inquest reports. Chrome ulceration caused the next highest number of cases—164. There were 52 cases of lead poisoning and for the fourth successive year there was no fatal case.

European Manager

Appointment of Mr. Harry J. Haon a manager of the European office of E. I. Du Pont de Nemours & Company, leading American chemical manufacturers, has been announced. Mr. Stanley R. Stager, Jr. who has been manager of the European office since 1952, is returning to a new assignment at the company's headquarters. Mr. Haon has been with Du Pont since 1934 He has an extensive background in sales and technical work for the company and was technical representative of the European office from 1929 to 1936.



Part of the high-pressure hydrogenation plant newly installed at Marchon Products Ltd., Whitehaven, for the production of fatty alcohols for detergents

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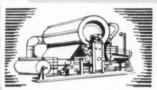
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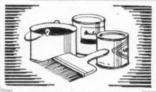
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Chemical Stocks & Shares During 1954

by J. E. REID

THE past year has been one of the most active ever experienced on the Stock Exchange. Share values, particularly in the industrial sections, recorded an almost continuous advance, stimulated by company results showing increased earnings and higher Despite the very big rise in market values, which carried many shares to the highest levels they have ever recorded. selling for the greater part of the year was only moderate. In fact, shortage of shares in the market was often an important factor accelerating the advance in prices. It was only toward the end of the year that selling developed on any scale, and this was followed later by renewed demand in most sections, with the exception of British Funds.

Sentiment became affected by talk that there might be signs of a revival of inflation dangers, and if this is borne out in 1955, and if the value of sterling does not improve, an increase in the bank rate might become necessary. It is this possibility of dearer money which accounts for the somewhat easier tendency recently in British Funds. Industrial shares, however, closed the year actively with some good individual features, encouraged by further news of higher dividends and by the expectation that financial results issued in 1955 will create an excellent Not only should earnings reimpression. flect the further expansion of activity in many industries, but net profits will benefit from the end of the EPL. Many shares have closed 1954 at around the peak levels recorded in the past twelve months.

Chemical and allied shares have moved fairly closely with the general trend in stock markets and responded to the excellent impression created by financial results, which reflected increased activity in most sections of the industry both in home and export markets. This favourable trend has continued, and the majority of results of chemical companies which fall to be issued in the first half of 1955 are expected to show a further good advance in profits. This expectation of course explains the continued strength and activity of chemical shares.

Imperial Chemical are closing the year at

42s. which is within 1s. 9d, of the highest price touched by the shares in the past twelve months, and compares with a lowest price of 26s. 6d. for the year, allowing of course for the adjustment of prices arising from the doubling of the ordinary capital by the free scrip issue of 100 per cent. Market hopes are that the year's total dividend on the doubled capital may be 9 per cent or possibly 10 per cent.

Monsanto have also been an active feature. The current price of 32s, compares with highest and lowest levels of 36s, 3d, and 21s. 7½d, during the year. Monsanto's half-yearly progress statement showed that the upward trend in earnings has been continued. Laporte 5s, ordinary units were also prominent, the company's progressive policy of expansion and the acquisition of other chemical businesses indicating continued confidence.

Albright & Wilson 5s, shares, which were 18s. 1½d, earlier in the year, and are now 26s, 9d., have not held best levels (the year's highest was 28s. 6d.) but this applies to many shares which have not yet fully recovered from the easier trend in evidence in stock markets at the beginning of last month. Fisons were a good feature on the results, their policy of expansion indicated by the acquisition of the Pest Control business. Fisons are now 58s. 6d. compared with extreme levels of 60s. 3d. and 41s. 9d. in the past twelve months.

The units of the Distillers Co. finished the year at 28s. 9d., their highest in the past twelve months, the increase in the interim dividend and the proposed writing up of the nominal value of the ordinary units being in accordance with highest expectations.

Borax Consolidated were one of the outstanding features. They have advanced from 37s. 9d. to 103s. 9d. and closed the year not far short of the latter level. The big rise reflects the fact that an American group may bid for control by making an offer of over £5 per share or its equivalent. But whether the bid will actually be made, and

[continued on page 188

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Stocks & Shares

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whether the directors would advise shareholders to accept, are unknown factors at the moment. Market view is that if there is no bid the directors are likely to raise the dividend considerably and perhaps make a special distribution of some kind as well.

Another big feature has been William Blythe 3s. shares, which were only 6s. 6d. a year ago and are now 20s. after reaching 23s. 3d. The big rise was accompanied by talk of a possible take-over bid, but the

rumour was unconfirmed. Reichhold 5s. shares responded to the much improved results, these shares having advanced on the year from 7s. 7½d, to 16s.

Oils also attracted strong buying, particularly British Petroleum on the Persian settlement and the big scrip issue. Allowing for the latter the BP shares at 84s. 3d. are at an all time record level, equal to £21 before the scrip issue was made. Shell have also recorded a big advance because of the assumption that the dividend total on the larger capital is likely to be at least 15 per cent, tax free.

				1.	19	154	Year	Current
Name				Class	High	Low	Ago	Price
Albright & Wilson		* *		5/- Ord.	28/6	18/11	18/6	26/9
Do				£1 5% Pref.	22/14	20/-	20/71	21/6
Bakelite				10/- Ord.	31/9	23/3	23/3	27/9
Berk, F. W., & Co				2/6 Ord.	7/6	5/9	5/71	7/-
Do				£1 4% Pref.	19/11	17/-	18/-	18/6
				3/- Ord.	23/3	6/11	6/6	20/-
			4.16	5/- Ord.		9/71		
Boake, Roberts, A.		2.5	* *		16/-		10/-	13/9
Borax Consld		8.6	4.8	£1 Def. Ord.	103/9	37/9	37/9	102/-
Boots Drug		4.4	* *	5/- Ord.	30/14	23/-	24/-	29/104
Bowmans Chemicals	7.0			4/- Ord.	6/11	5/-	4/-	5/-
Do.		* *		£1 51% Pref.	12/6	11/-	10/-	12/6
British Celanese	4.4		2.2	£1 Ord.	32/11	25/-	26/-	28/74
British Chrome & Chemicals				5/- Ord.	15/43	8/3	16/6	13/3
British Glues & Chemicals				4/- Ord.	14/71	7/10%	11/6	12/9
Do.				£1 8% Pref.	29/3	26/3	30/6	29/3
British Industrial Plastics	4.3			2/- Ord.				
		* *		2/- Ord.	5/101	3/71	5/41	5/71
Do.	4.5	x 9	4.5	2/- 10% Pref.	7/6	5/71	5/9	7/6
	* 9		4.8	£1 Ord.	67/9	51/101	57/3	62/3
Do		* *		£1 61 % Pref. £1 5 % Pref. £1 4% Pref.	28/101	26/-	27/-	28/3
Do				£1 5% Pref.	22/6	20/3	21/-	22/-
Do				£1 4% Pref.	18/71	16/101	17/-	18/-
British Petroleum				£1 Ord.	80/3	33/1%	33/9*	84/3
				£1 Ord.	46/6	27/3	27/6	42/6
				2/- Ord.		2/3		
Coalite & Chemical		* *			4/41		2/71	4/-
Cooper, McDougall & Rober	rtson		0.7	£1 Ord.	28/101	20/3	27/6	26/6
Do.			6.8	£1 7% Pref.	24/101	23/3	24/6	24/9
Courtaulds				£1 Ord.	40/101	25/3	25/6*	40/10
Distillers				4/- Ord.	28/9	17/71	17/71	28/9
Do				£1 6% Pref.	27/6	24/-	25/6	-26/9
Fisons				£1 Ord.	60/3	41/9	41/6	58/6
-				£1 41 % Pref.	20/6	18/3	18/71	20/-
		* *	5.6					102
Do				41 Debs.	1031	981	997	
Glaxo Laboratories	4.4	A 4.	1.4	10/- Ord	72/-	43/6	43/9	66/-
Greeff-Chemicals Holdings		* *		5/- Ord.	16/41	7/3	14/41	13/10
Do.				10/- 51 % Pref.	10/3	9/41	9/41	10/-
Hardman & Holden				5/- Ord.	13/-	9/9	10/41	11/3
Hickson & Welch				10/- Ord.	20/~	9/41	9/3	20/-
Do				£1 6% Pref. £1 4½% Pref.	20/43	20/3	18/3	21/101
				61 Al 0/ Prof	16/9	15/6	16/11	16/3
		* *	h. e	£1 Ord.	17/~	14/3		16/-
		* *	2.5				15/6	
Do	5.5	4.0	* *	£1 51% Pref.	17/6	16/3	16/9	17/-
Do		5 5	8.4	5/- Deb.	99	98	971	971
Imperial Chemical Industries				£1 Ord.	43/9	26/6	26/9*	42/-
Do.				£1 5% Pref.	23/-	19/6	27/101	22/-
Ilford		4.6	* *	5/- Ord.	17/-	9/6	14/41	15/6
Do				£1 6% Pref.	25/-	23/6	23/9	24/3
Johnson Matthey				£1 Ord.	47/9	26/9	27/-*	46/3
				5/- Ord.	18/101	9/3	12/41	17/6
		1. 10	N 16	10/- Ord.	17/3	11/3		15/104
Lawes Chemical		+ +	4.4				11/3	40/-
Midland Tar Distillers	* 6	N . W		£1 Ord.	44/41	31/3	33/9	
Monsanto Chemicals	* *			5/- Ord.	36/3	21/74	21/9	32/-
Do.			6.6	£1 31% Pref.	16/101	15/-	15/101	16/-
Do.		1 4		£1 31% Pref. £1 41% Pref.	20/6	18/101	19/44	23/3
Permutit	-			5/- Ord.	14/-	8/71	8/71	12/6
Reichhold Chemicals		4.4		5/- Ord.	16/-	7/6	7/7	16/-
CI II T				£1 Ord.	6.1	328	432*	6
			* 4	£1 Ord.	6432		2432	63/9
Staveley Coal & Iron					04/~	33/3	34/9	80/-
Unilever		7.7		£1 Ord.	86/-	46/3	46/3*	40 -
United Molasses				10/- Ord.	40/-	31/-	33/-	
United Indigo & Chemical				2/- Ord.	2/6	1/6	2/-	2/-
Yorkshire Dye & Chemical		1.4	2.4	5/- Ord.	12/6	8/3	8/3	11/3
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Ion Exchange today performs many tasks in industry, and Permutit manufactures a wide range of these materials. Their application in roles distinct from water treatment has resulted in the development of numerous new industrial processes giving improved results and lower running costs. Some of the materials

now available, with their characteristics, are shown below.

- ZEO-KARB Na A sulphonated coal product containing both strong and weak acid groups.
- ZEO-KARB 215 A nuclear sulphonated phenol resin containing also hydroxyl groups.
- ZEO-KARB 225 A unifunctional cross linked sulphonated polystyrene resin in head form of high capacity and exceptional chemical and physical stability
- ZEO-KARB 226 A unifunctional cross linked methacrylic acid resin in bead form containing only carboxyl groups as the ion active groups.
- **DE-ACIDITE E** A high capacity anion exchange material of medium basicity.
- DE-ACIDITE FF A unifunctional very highly basic anion exchange resin in head form based on cross linked polystyrene and containing quaternary ammonium groups.

- DE-ACIDITE G A unifunctional weakly basic exchange resin in bead form based on cross linked polystyrene and containing diethylamine groups.
- DE-ACIDITE H A material similar to "De-Acidite G" but containing dimethylamino groups.
- BIO-DEMINROLIT A mixed cation and amou exchange resin for demineralisation in a single column.
 - DECALSO F A synthetic sodium alaminium silicate suitable for the separation and concentration of vitamins and hormones.
 - DECOLORITE A resin of high perosity for removing colour from solutions.
- PERMAPLEX C-10 A highly selective cation exchange resin membrane containing SO₂H groups.
- PERMAPLEX A-10 A highly selective anion exchange resin membrane containing quaternary ammonium groups.

For full technical information please write to:

THE PERMUTIT COMPANY LIMITED

Dept. V.A. 150, Permutit House, Gunnersbury Ave., London, W.A. Tel.: CHIswick 6431

· HOME

Oil Search in Sussex

An oil-prospecting licence has been granted by the Minister of Fuel and Power to D'Arcy Exploration Company, the prospecting subsidiary of the British Petroleum Company, covering an area of approximately 119 square miles in Sussex.

Aluminium Price Rise

The UK price of Canadian aluminium ingot has been raised by £7 to £163 a ton delivered. This price is almost identical with an increase announced by Aluminium Company of Canada of ½ cent per lb. to Canadian users and with related increases in its prices for metal delivered to other overseas markets.

Rayon Output

Although production in the rayon industry last November was 2 per cent below the level for October, the rate of production was fully maintained and the fall in output is wholly accounted for by the shorter month. Output during the month totalled 38,000,000 lb., 5 per cent more than in November, 1953. October output was 38,900,000 lb.

Production Rise Expected

Production in many parts of the US chemical industry is expected to reach record heights during 1955, according to a survey made by Mr. Weeks, Secretary of Commerce. Synthetic fibres and plastics are expected to continue expanding at a rate that would double their capacity in five years.

Exemptions from KID

The Treasury has made an Order under Section 10(5) of the Finance Act, 1926. exempting the following articles from Key Industries Duty for the period beginning 23 December 1954 to 18 February 1955: isobutyl alcohol: 2-ethylhexyl diphenyl orthophosphate: methyl cyanide: phosphor-This Order is the Safeous acid. guarding of Industries (Exemption) (No. 12) Order, 1954, and is published as Statutory Instruments 1954 No. 1683. Copies may be obtained (price 2d. net, by post 3d.) from HM Stationery Office, Kingsway, London. W.C.2 and branches, or through any bookseller.

More Steel in Britain

British steel production during 1954 is expected to total 18,500,000 tons, compared with 17,600,000 tons in 1953. Since the war steel output in this country has risen by 45 per cent, an increase comparable to that in the United States in the same period

Increased Radio-isotope Output

Production of radio-isotopes in the UK is expected to reach about 20,000 consignments in 1955, compared with between 16,000 and 17,000 in 1954. About one-third will be exported, to more than 40 countries, including the US.

BIMCAM Annual Luncheon

The annual luncheon of the British Industrial Measuring and Control Apparatus Manufacturers' Association will be held at Londonderry House, 19 Park Lane, London W.1, on 18 January. The principal speakers will be Sir Edward Boyle, Parliamentary Secretary to the Ministry of Supply, and Sir Roger Duncalfe, chairman of British Gluss and Chemicals Ltd. and deputy chairman of the Beaver Committee on Air Pollution.

I.C.I. to Market Sheep-Marking Fluid

Bradford Sewage Committee have recommended that the pharmaceutical division of I.C.I. should market the new sheep-marking fluid evolved by chemists of the Bradford Corporation By-Products Department at the Esholt Sewage Works. I.C.I. would be the sole marketing agents but the retail price would be subject to control by Bradford Corporation, and any variation in price would be subject to agreement between the I.C.I. and the Corporation.

The Midland Tar Distillers Ltd.

Improved trading results were reported at the annual general meeting of The Midland Tar Distillers Ltd. held on 17 December. The trading profits for the year ended 30 June were £331,141, an increase of more than £20,000 compared with the previous year. The recommended dividend of 10 per cent (8 per cent for the eight previous years) was approved.

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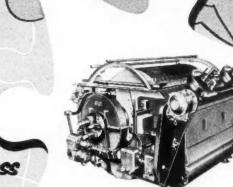
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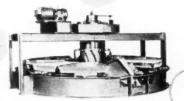
Whatever your filtration problem there is an Eimco Filter specially designed for the job. Eimco Filters have been built in close of the polishoration with industry for many years, and their world-wide use testifies to their efficiency and reliability. They are used in the Cement, Chemical, Coal, Food, Paper, Petroleum, Sewage, Starch, Sugar and other industries for Clarifying, Dewatering, Drying, Washing and other recovery processes.

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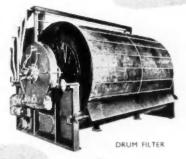
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OVERSEAS

Du Pont Reduce Prices

Du Pont de Nemours and Co. of America have reduced the price of two major types of neoprene synthetic rubber from 41 to 39 cents per pound.

Output in Western Canada

Western Canada's oil production during 1954 is estimated at about 95,910,000 barrels, worth \$245,296,000. Daily average output is estimated at 262.768 barrels, an increase of 18 per cent on the 1953 average of 222,428 barrels.

Canadian Industries (1954) Ltd.

A dividend of 15 cents per share is declared on the common stock of Canadian Industries (1954) Ltd., payable on 31 January and making with the initial dividend of 10 cents per share paid in October a total of 25 cents per share for the financial period 1 July to 31 December, 1954.

High World Oil Output

An estimated 710,000,000 metric tons of crude oil and natural gasoline were produced throughout the world in 1954, 30,000,000 tons more than in 1953 and almost double the output figure of 1953.

Chilean Nitrate Agreement

The board of Anglo-Lautaro Nitrate Corporation has authorised the signing of a memorandum of agreement embodying amendments to the basic law governing the Chilean nitrate industry. The agreement is the culmination of long negotiations and is designed to strengthen the competitive position of the Chilean nitrate industry by the elimination of unrealistic exchange rates.

Synthetic Rubber Plants

The US Rubber Disposal Commission has sold 24 of the Government's 27 synthetic rubber plants to private industry, and an offer has been made to lease one of the remaining ones. Sale prices will not be announced until the commission reports to Congress by 27 January. The contracts become final if they are not vetoed by Congress within 60 days.

Fertiliser Unit Planned

Preliminary planning by Consolidated Mining and Smelting Company of Canada for a new area fertiliser unit in the northwestern United States, possibly near Portland, Oregon, is now under way.

Manganese Find in Canada

A potential 150,000,000 tons of manganese have been indicated in the Woodstock area of New Brunswick. Drilling operations proved an area of almost 18 miles in length, and tests indicated a composition of about 12 per cent manganese and 16 per cent iron ore.

Tapping CO2

A new industry, tapping vast supplies of cheap natural carbon dioxide gas, will soon go into production near Consul, Sask Gas-Ice Corporation of Canada Limited will bring up carbon dioxide from a well near Consul, then process it at the wellhead to make liquid carbon dioxide and 'gas ice.'

New Oil Search Company

A second company for the financing of oil exploration in France and her overseas territories is to be established in Paris on 15 January. Its name will be Compagnic Financière de Recherches Petroliers and its initial capital will be Frs.100,000,000. The first company, Société Financière des Petroles, is increasing its capital.

Chemicals for Finland

Although many products needed by the Finnish chemical industry are obtained from the Eastern bloc for currency reasons, there is a large number of products which have to be bought from western countries. According to Teknillisen Kemian Aikakawilehti,the journal of Finnish industrial chemistry, standards of products imported from the eastern bloc have improved lately, but the time of delivery varies from one to three months Principal with relatively frequent delays. products include organic and inorganic chemicals, pigments, coal-tar products pharmaceuticals, cosmetics and textile and leather auxiliaries.

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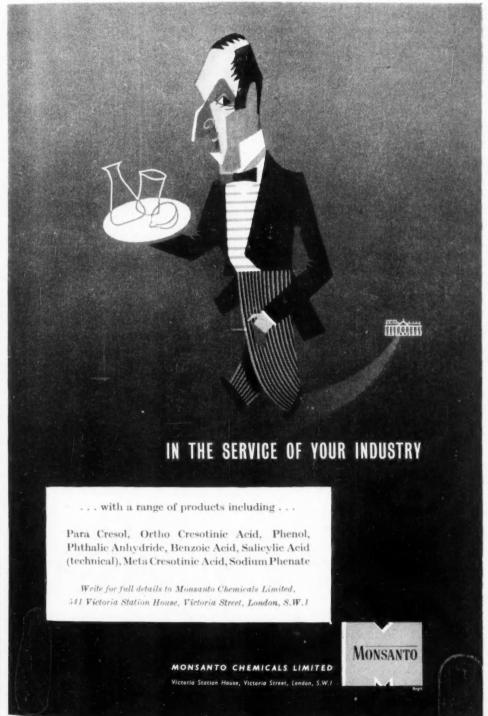
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· PERSONAL

MR. ERNEST STANLEY SELLERS, M.A., M.Sc., A.M.I.Chem.E., university lecturer in chemical engineering at Cambridge, has been appointed by the council of Swansea University College to the newly established Chair of Chemical Engineering (see THE CHEMICAL AGE, 1954, 71, 1187) and will start his duties next October. Mr. Seller's industrial career has included three years at the Abadan refinery of the Anglo-Iranian Oil Company. Later he was at the Trafford Park refinery of the Manchester Oil Refinery Ltd., and in October, 1948, he was appointed to a university lectureship in the School of Chemical Engineering at Cambridge. He is a member of various Government committees, and author of a number of technical publications. A course leading to degrees in chemical engineering will be instituted at Swansea University College from the beginning of the session 1955-56.

Coun. J. C. Mellor, B.Sc., A.R.I.C., of Marsden, has retired after 35 years' service with the Clayton Aniline Co. Ltd., Manchester. He joined the firm as senior chemist and eventually became assistant technical manager. He has also become one of the best-known public men in the Colne Valley and has been a councillor for 25 years.

The retirement has occurred of MR. RAYMOND R. BUTLER, M.Sc., F.R.LC., F.I.I.A., who has been Principal of the Liverpool College of Technology since 1934. In that time he has seen the college develop from a central technical school to one of the large colleges of technology in the country. A new college is in the city's building programme for 1955-56. During his career. which started in 1889, Mr. But'er has held both research and teaching posts. He has been a lecturer in physical and applied chemistry at the Northern Polytechnic, London, head of the department of chemistry at Plymouth Technical College and principal of Birmingham Technical College and has written papers and articles on education and in scientific journals. He is a Fellow of the Chemical Society and has been a member of the Council of the Royal Institute of Chemistry, a founder member of the British Institute of Management, a member of the Association of Principals of Technical Institutions council, chairman of the Standing Committee of the Merseyside Regional Advisory Committee for Further Education and chairman of the Committee's Chemistry Advisory Committee.

After 40 years with Dunlop, Mr. Frederick Walker, O.B.E., M.I.Mech.E., chief engineer at Fort Dunlop, retired on 31 December. Mr. Walker is chairman of the Midland branch of the Institution of Mechanical Engineers and also a member of Council of the Institution. During the war and afterwards he served either as member or chairman of the Midland Regional Fuel Efficiency Committee, on the Ministry of Fuel and Power's central committee, and the British Rubber Manufacturers' fuel committee.

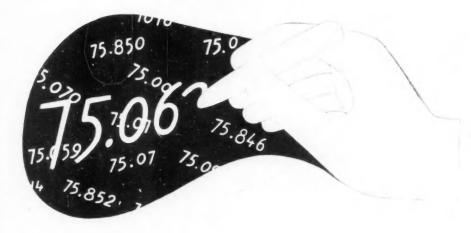
After 35 years' association with John W. Leitch & Co. Ltd., of Huddersfield, Dr. A. E. EVEREST, Ph.D., D.Sc., F.R.I.C., has retired Dr. Everest joined the company as chief chemist and was appointed a director shortly afterwards. He has been a member of the council of the Association of British Chemical Manufacturers for 20 years and is a former vice-president of the Royal Institute of Chemistry. The share capital of John W. Leitch & Co. Ltd. was recently acquired by Hickson & Welch (Holdings) Ltd. (see The Chemical Age, 1954, 71, 1364).

MR, WILLIAM JOSEPH VICTOR WARD, B.A. A.R.C.Sc., who has been technical director of the Billingham Division of Imperial Chemical Industries Ltd. since 1949, has been appointed chairman of the Division in succession to Dr. Geoffrey Isherwood His son, D.Sc., F.R.I.C., F.R.P.S., who is retiring. The appointment is effective from 1 February. Mr. Ward, who is 52, joined the Billingham Division in 1926 and worked at first in the research department. By 1932 he had risen to be senior plant manager in the process department and later in the same year took charge of the Drikold group. For four years he was chief technical assistant on the directorate staff, and in 1944 joined the Division technical department as ammo-He was later nia technical manager. promoted to take charge of the technical

continued on page 16

...confirmed by the experts

"The mean for these experiments gives 75.07. We therefore consider 75 as the true number indicated by these experiments for the atomic weight of carbon. It is remarkable that this number was fixed upon theoretically by the English chemists and has now been confirmed by experiments."



DR. MARCHAND OF BERLIN made this statement in a letter recorded in the first volume of the Proceedings of the Chemical Society (1841), challenging the claim of Liebig and Redtenbacher to have established 75.854 as the correct atomic weight for carbon. In those days atomic weights were related to oxygen as 100, and it is notable that the 1951 atomic weight for carbon calculated on this basis is

75.063 compared with Marchand's figure of 75.07 derived from the combustion of diamond and graphite.

Dr. Marchand, whose methods were simple and direct, would have welcomed the convenience and accuracy of 'AnalaR' reagents. It is even possible that they would have assisted the highly elaborate analytical work of Liebig and Redtenbacher to a more successful result.

LABORATORY B.D.H CHEMICALS

THE BRITISH DRUG HOUSES LTD. B.D.H. LABORATORY CHEMICALS GROUP POOLE DORSET

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Personal

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department, relinquishing this position in December, 1949, on his appointment to the Division board as technical director. Dr. Higson joined the Division in 1922, and, with the exception of two years during which he was seconded to Canadian Industries Ltd., has spent the whole of his company service at Billingham. For a number of years he was technical department manager and was appointed successively technical director and joint managing director. He became chairman of the Division in 1951.

MR. CLIFFORD PAINE, M.Sc., A.M.C.T., chairman of the Dvestuffs Division, and MR. WILLIAM DONALD SCOTT, B.Sc., a managing director of the Billingham Division, have been appointed to the board of Imperial Chemical Industries Ltd. as executive directors. Mr. Paine, chairman of the Dvestuffs Division since November 1952, started his career in the dyestuffs industry in 1917, when he joined the research department of Levinstein Ltd. He specialised particularly in the dyestuffs and intermediates fields, in which he made a number of inventions. In 1937 he was seconded to I.C.I. (New York), later returning to Blackley, where he was appointed leader of the exploratory research section of the Dyestuffs Division. He became assistant research manager of the Division in 1942, research manager in 1943 and research director in 1946. Mr. Scott worked for some years with the Hercules Powder Co. Ltd., in America and Holland. In July 1935, he joined I.C.I. in the Explosives Division sales department and six years later was transferred to the Dyestuffs Division as market development officer, later becoming home sales manager for the Division. In 1951 he went to the Billingham Division, being appointed joint managing director (commercial) in the following year.

MR. J. A. PENTECOST, for many years sales controller of A. Boake, Roberts & Co. Ltd., has now been appointed to the board of directors

Obituary

The death in New Delhi was reported on 1 January of Sir Shanti Swarupa Bhatna-Gar, O.B.E., F.R.S., secretary of the Indian Ministry of Natural Resources and Scientific

Research. Generally recognised as India's greatest scientist. Sir Shanti Bhatnagar was educated in Lahore, London and Berlin studying in the Sir William Ramsay Labora. tories at University College, 1919-1921. On returning to India he was elected to the chair of chemistry in the Benares Hindu University. In 1924 he was appointed Director of the University Chemical Laboratories of the Punjab. He was made an O.B.E. in 19% and knighted in 1941, and the Fellowship or the Royal Society was conferred on him in 1943. He was the founder of the Lahore Research scheme for work on petroleum and allied subjects and took an active part in the work of the Indian Science Congress, being its president in 1944. He was a tireless research worker and published a great number of scientific papers covering a wide field He was 59.

MR. FREDERICK W. HARRIS, who has died at his home in Uddingston, aged 84, was formerly Corporation Chemist and Public Analyst for the City of Glasgow. He was native of South Wales and held appointments in England before coming to Glasgow, notably that of Public Analyst of Burnley During the 35 years spent in this appointment, Mr. Harris was recognised as an authority on the chemistry of sewage purification and the study of the abatement of air pollution. A lecturer, Mr. Harris was also author of numerous publications of technical subjects. He retired in 1935.

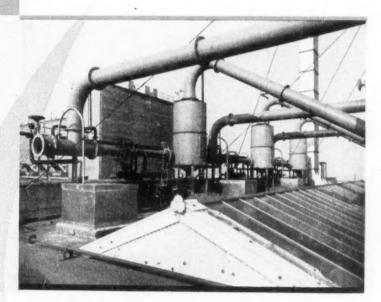
The death occurred on 29 December in the Royal Masonic Hospital, Hammersmith of Mr. RALPH SAMUEL HARBORNE, M.S. F.R.I.C., M.I.Chem.E., of Moor Park. Northwood, Middlesex. Mr. Harborne, who was 57, was joint managing director and chairman of Base Metal Products Ed. North End Road, Wembley. He became an Associate of the Royal Institute of Chemistry in 1923 and a Fellow in 1950, in which year he also became a Member of the Institution of Chemical Engineers, having been an Associate since 1930.

Inventor of the Burton thermal petrol cracking process, DR. WILLIAM BURTON has died in Miami at the age of 89. He was a former president of Standard Oil Co. of Indiana.

We regret to announce the death after a long illness of Mrs. Isabel MITCHELL FLECK of Norton Hardwick, Stockton-on-Tees, wife of Dr. Alexander Fleck, chairman of I.C.

PEASE-ANTHONY

GAS SCRUBBERS



The photograph shows a recent installation for treatment of fumes from lead furnaces. Other successful installations are working on lime kilns, zinc furnaces, spray dryers, superphosphate plants, etc. Pease-Anthony Scrubbers are being used more and more to deal with dust and fume removal in industry.



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Law & Company News

Commercial Intelligence

The following are taken from the printed reports, but we cannot be responsible for errors that may occur.

Mortgages & Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages or Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary but such total may have been reduced.)

POLYMER (UNITED KINGDOM) LTD., London E.C., merchants agents, etc., synthetic rubber, plastics, etc.—29 November, second deed supplemental to a debenture dated 4 August 1952 and further increasing the limit of the amount secured thereby from £150,000 to £400,000 (and first supplemental deed ceased to have effect), to Bank of Nova Scotia; charged on property, etc., charged by original debenture. *£138,028. 4 May, 1954.

Company News Midland Silicones Ltd.

Albright and Wilson Ltd. announce that, under arrangements recently completed, the ownership of their silicone manufacturing plant at Barry, South Wales, has been transferred to Midland Silicones Ltd., the company already established to distribute these products. Albright and Wilson are majority shareholders in Midland Silicones Ltd., the balance of the shares being held by Dow Corning Corporation of America. The latter company has been closely associated with Albright and Wilson in establishing the manufacture of silicones in this country, and Midland Silicones Ltd. will continue to benefit from Dow Corning's experience and research in this important chemical field.

Willows Francis Pharmaceutical Products Ltd.

At an extraordinary general meeting of Willows Francis Pharmaceutical Products Ltd., held in London on 29 December, following the annual general meeting of the company, the following resolution was duly approved as a special resolution:

Resolved that, with the consent of the Board of Trade, the name of the company be changed to Willows Francis Ltd.

Allen & Hanburys Ltd.

Net group profit of Allen and Hanburys Ltd. after tax was £81,805, compared with £70,882. At the annual general meeting on 30 December it was reported that turnover was slightly down, mainly because a number of unremunerative products had been discontinued and a number of export markets. in which the profit margins were narrow. had contracted. A total distribution of 171 per cent on the ordinary shares was approved. At the meeting Mr. J. C. Hanbury, chairman, announced that the board had decided to convert the firing of the boilers at Ware from coal to creosoft The switch-over, he said, would be effected some time during the next few months.

B.I.P. Chemicals Ltd.

As from 1 January 1955 the manufacture and sale of moulding powders, synthetic resins and other plastic raw materials, a present carried out by British Industrial Plastics Ltd. at its factories at Oldbury will be transferred to a wholly-owned subsidiary company, B.I.P. Chemicals Ltd.

This newly formed company will take over responsibility for all the technical design and sales services at present provided by British Industrial Plastics Ltd., and will maintain the same offices; all correspondence should therefore be addressed as at present apart from the alteration of name B.I.P. Chemicals Ltd. will fulfil all orders placed before I January 1955 and after that date all orders should be addressed to the new company.

The new company will take over the collection of all monies due to British Industrial Plastics, Ltd., and it would be appreciated if, after 1 January 1955 all remittances are addressed to B.I.P. Chemicals Ltd. at Popes Lane, Oldbury, Birmingham. Customers paying by Traders' Credit are requested to note that the new company's bankers are National Provincial Bank Ltd., Bennetts Hill, Birmingham.

Similarly, B.I.P. Chemicals Ltd. will act as paying agent for all goods delivered and

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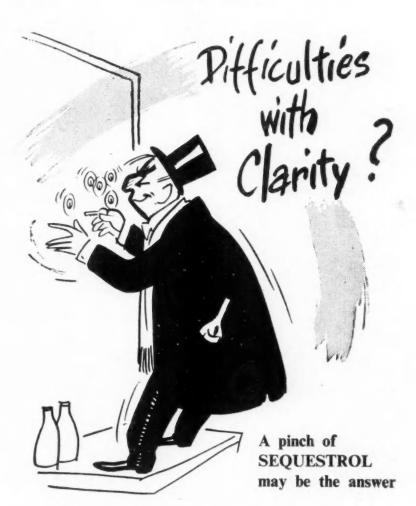
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Haze and sludge in the most diverse aqueous solutions—from liquid soaps to beverages, photographic developers and pickling baths—can often be prevented by a small amount of SEQUESTROL (ethylene-diamine-tetra-acetic acid Geigy) which solubilises a wide range of heavy metal compounds, for example barium sulphate, lime soaps, or metal/protein complexes. Recommendations on request.

THE GEIGY COMPANY LTD., Rhodes, Middleton, MANCHESTER



Next Week's Events

MONDAY 10 JANUARY

Society of Chemical Industry

London: Chemical Society's Rooms, Burlington House, Piccadilly, 6.30 p.m. London Section meeting. 'Trends in the German Chemical Industry since the War' by Dr. F. Ehrmann.

Institute of Fuel

Newcastle-on-Tyne: Chemistry Lecture Theatre, King's College, 6.30 p.m. 'Carbonisation of Blends of Coal to Produce Metallurgical Coke' by H. Bardgett.

TUESDAY 11 JANUARY

Royal Institute of Chemistry

Gravesend: Technical College, Mayfield Hall Annexe, Pelham Road, 7.30 p.m. 'The use of Photography in Scientific and Engineering Investigations' by Dr. R. H. Herz.

Society of Chemical Industry

London: Geological Society, Burlington House, Piccadilly, 5.30 p.m. Chemical Engineering Group meeting on 'Refrigeration.' Speakers, E. Griffiths, J. C. Fidler and R. A. K. Long.

London: Chemical Society's Rooms, Burlington House, 6.30 p.m. Plastics and Polymer Group meeting. 'Measurement of Molecular Weight by the Light Scattering Method' by Dr. D. Cleverdon.

Midlands Society for Analytical Chemistry

Birmingham: Mason Theatre, The University, Edmund Street, 6.30 p.m. 'Analytical Chemistry of Titaniferous Materials' by Dr. F. R. Williams.

WEDNESDAY 12 JANUARY

Society of Chemical Industry

London: Institution of Civil Engineers, Great George Street, S.W.1, 2.15 p.m. Joint meeting of the Microbiology Group with the Society for Applied Biology on 'Aeration in Industrial Fermentations,'

London: Chemical Society's Rooms, Burlington House, Piccadilly, 6.30 p.m. Food Group domestic meeting, 'Chemical, Physical and Structural Characteristics of Egg Shells' by Professor C, Tyler.

THURSDAY 13 JANUARY

Chemical Socie'v

Aberdeen: Robert Gordon's Technical

College, 7.30 p.m. 'Application of Science in the Detection of Crime' by Dr. J. B. Firth.

Bristol: Department of Chemistry, The University, 7 p.m. 'Some Experience of Food Legislation during the War' by Sir Harry Jephcott.

Edinburgh: North British Station Hotel, 7.30 p.m. 'Organic Inclusion Compounds' by Professor W. Baker.

Manchester: Chemistry Lecture Theatre, The University, 6.30 p.m. 'Colouring Matters of the Aphididae' by Sir Alexander Todd.

(All the above are joint meetings with RIC and SCI.)

Institute of Fuel

London: Institution of Civil Engineers, Great George Street, S.W.1, 5.30 p.m. 'Integration in the Iron and Steel Industry' by W. F. Cartwright.

Textile Institute

Manchester: 10 Blackfriars Street, 7 p.m. 'Continuous Bleaching and Preparatory Processes' by F. W. Thomas.

FRIDAY 14 JANUARY

Chemical Society

Birmingham: Chemistry Department, The University, 4.30 p.m. 'The Structures of Electron-deficient Substances' by Professor H. C. Longuet-Higgins.

Portsmouth: Municipal College, Anglesea Road, 7 p.m. 'Fission Products' by P. E. Carter.

Society of Chemical Industry

London: Chemistry Lecture Theatre, King's College, Strand, W.C.2, 7 p.m. Fine Chemicals Group. 'The Synthesis of Radiochemically Labelled Fine Chemicals' by Dr. H. S. Turner.

Oil & Colour Chemists' Association

Manchester: The Engineers' Club, Albert Square, 2.30 p.m. 'Emulsion Polymerisation' by Dr. L. B. Morgan.

Society of Cosmetic Chemists of Great Britain

London: Royal Society of Tropical Medicine and Hygiene, 26 Portland Place. W.1, 7 p.m. 'Waxes' by Dr. L. Ivanovszky.

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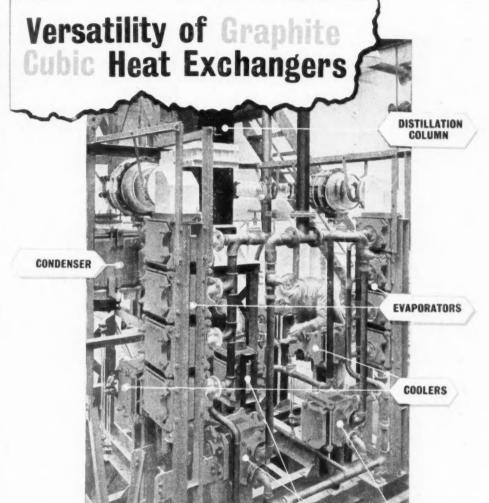
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The photograph shows a complete plant designed to evaporate a liquor containing Hydrochloric acid, to recover, by condensation and distillation, the Hydrochloric acid evolved, and finally to cool all products to room temperature. 'Delanium' Graphite Cubic Heat Exchangers shown in this illustration have been adapted to perform all the above heat transfer operations and demonstrably provide compact, robust and versatile corrosion free plant.

PREHEATERS

REBOILER

POWELL DUFFRYN CARBON PRODUCTS

Next Week's Events

continued from page 200

Institute of Fuel

Manchester: The Engineers' Club, Albert Square, 2.15 p.m. 'Sulphur Removal and Recovery within the Gas Industry' Papers 6 and 7 (joint meeting with the Institution of Gas Engineers, Manchester and District Section).

Society of Instrument Technology Ltd.

Glasgow: Natural Philosophy Department, Royal Technical College, 7 p.m. Discussion on 'Installation of Temperature Measuring Instruments.'

Company News

continued from page 198]

services rendered relating to the factories at Oldbury under orders and forward contracts placed by British Industrial Plastics Ltd, prior to 1 January 1955 and suppliers are requested to accept payment from B.I.P. Chemicals Ltd, on behalf of this company.

Powell Duffryn Ltd.

The board of Powell Duffryn Ltd. have decided to submit to meetings of the stockholders, to be held on 18 January, a scheme for reorganising the capital of the company. It is designed primarily to effect a reduction on the issued share capital by returning to members cash no longer required in the business. The scheme, briefly, provides for repayment of 10s, in the £ on the £3,600,000 cumulative preference stock, together with a premium of 1s, per 10s, stock repaid, and repayment of 19s, in the £ on the £9,660,471 ordinary stock with payment of a special dividend of 2s. 6d. (less income tax) per £1 unit of ordinary stock. Among the supplemental provisions is one for the capitalisation of £4,347,211 19s. by means of a free distribution of nine ordinary shares of 1s. each fully paid to holders of each 1s. ordinary stock or share remaining after the 19s. in the £ repayment. The result of the scheme will be to halve the issued capital of the company.

Thomas Tyrer & Co. Ltd.

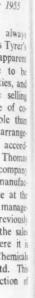
For many years Thomas Tyrer and Co. Ltd., a subsidiary company of Albright and Wilson Ltd., has been trading as a separate entity manufacturing and selling a wide range of fine chemicals under its own name.

Although the parent company has always maintained a close interest in Thomas Tyrer's activities, it has recently become apparent that for the maximum advantage to be taken of the group's research facilities, and for the most efficient use of the selling organisation, an even closer degree of cooperation will in future be desirable than has been possible under the existing arrange Albright and Wilson have accordingly decided to end the activities of Thomas Tyrer and Co. Ltd. as a separate company from 31 December 1954. The manufacture of fine chemicals will continue at the Stratford works under the same management. The selling organisation previous located at Stratford will move to the sales office at 49 Park Lane, W.1, where it is proposed to set up a Fine Chemicals Division of Albright and Wilson Ltd. This division will be under the direction of Mr. A. W. R. Chandler.

Market Reports

LONDON .- A steady call for supplies ha been reported from most sections of the market, and there has been a certain amount of buying for stock rather than for imme diate requirements. Firm prices have been maintained for the soda products and quoutions are unchanged. Contract rates for oxalic acid remain unchanged. The New Year has begun with a number of items it none too plentiful supply, among which are citric acid, tartaric acid, hydrosulphite of soda, and sodium silicofluoride. The con tar products market is firm, available sup plies of most items finding a ready outlet Quotations for cresylic acid, other than for bulk quantities, are slightly dearer.

MANCHESTER.—Although not yet back into full swing after the seasonal slackness the Manchester market for heavy chemicals has been fairly active during the past week. Additional inquiries have been dealt with on both home and export accounts and domestic users of the alkalis, as well as the potable ammonia and magnesia compounds, have been calling for reasonably good quantities against contracts. Prices generally are on a steady to firm basis. A quiet movement of the fertiliser materials has been reported. In the market for the tar products a steady call for most lines has been resumed.



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CLASSIFIED ADVERTISEMENTS

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive, or a woman aged 18-59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notifications of Vacancies Order, 1952.

A. BOAKE, ROBERTS & CO. LTD., LONDON, E.15, require SENIOR CHEMISTS for their Process Development Dept. These appointments would appeal to qualified men with some years experience of organic chemistry, seeking the opportunity to lead a team in developing new projects from laboratory to plant scale so as to provide new or improved products. The minimum salary envisaged is £800 per annum. Write, giving full details of qualifications and experience, to THE PERSONNEL MANAGER.

A RMSTRONG SIDDELEY MOTORS needs a CHEMIST as assistant to the Chief Chemist in their Rocket Division for research in an unusual field, with a wide range of materials. Degree or A.R.I.C. essential.
Good prospects. Apply giving details of experience to
Reference CG/RLI, TECHNICAL PERSONNEL
MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY.

CHEMICAL Engineering Company in Westminster district have several vacancies for ASSISTANT ENGINEER. Qualifications are: age about 25-30, B.Sc. standard, good knowledge Physics, Mathematics and Chemistry desirable. Understanding of general office procedure an advantage. The position offers excellent opportunities for a man having these qualifications coupled with a keep husiness outflook. Write tions, coupled with a keen business outlook. Write, stating fullest possible particulars, including age, qualifications and salary required, to BOX No. C.A. 3375, THE CHEMICAL AGE, 154, FLEET STREET, LONDON,

CHEMIST—approximate B.Sc. standard—required for CHEMIST—approximate 8.8c. standard—required for the Chemical Laboratory of THE RUBBER RE-GENERATING CO. LTD., who manufacture a wide variety of materials for the rubber trade. Applications are invited from suitably qualified persons fully able to carry out accurate analytical work. Excellent prospects. Staff Bonus, Pension and Life Assurance Schemes. Replies, giving details of age, education and experience, should be addressed to: PERSONNEL MANAGER, THE RUBBER REGENERATING CO. LTD., FIRST AVENUE, TRAFFORD PARK, MANCHESTER.

JOHNSON, MATTHEY & CO. LIMITED require two GRADUATE CHEMISTS, age 25-35, for the research laboratories of the Ceramic Division located in the N. Midlands.

One man is required for investigation into pigments and experience of the paints or plastics industries would be considered an advantage.

The second man is required for research in the field of

The second man is required for research in the field of ceramic colours for the glass and pottery industries. The appointments will be made to the permanent staff and carry full superannuation. Salary according to qualifications and experience, Write giving full particulars of age, education and experience to THE SECRETARY, JOHNSON, MATTHEY & CO. LTD., 78 HATTON GARDEN, E.C.1.

SITUATIONS VACANT

HEMIST TECHNOLOGIST required by THE RUBBER CHEMIST TECHNOLOGIST required by REGENERATING CO. LTD., to take charge of physical control of the control of th testing of rubber and allied materials for bulk control and development work. Applicants should have rubber works and laboratory experience and have attained A.I.R.I. standard. Excellent prospects of advancement Staff Bonus, Pension and Life Assurance Scheme Replies, giving details of age, education and experience should be addressed to: PERSONNEL MANAGER, THE RUBBER REGENERATING CO. LTD., FIRST AVENUE. TRAFFORD PARK, MANCHESTER.

HER MAJESTY'S OVERSEA CIVIL SERVICE VACANCIES exist for CHEMISTS in the Government Chemist Departments of (a) Tanganyika (BCD 97/8/01) and (b) Federation of Malaya (BCD

QUALIFICATIONS: Honours degree in Chemistry or Associateship & Royal Institute of Chemistry, Age limits 25

30 years. Honours degree in Chemistry with Associateship Fellowship of Royal Institute of Chemistry. Iw years specialised experience in some line (Foress Science; Toxicology; Foods; Drugs and Water Bacteriology; Pharmacy; etc.), relevant to the work in Malaya, or research experience indicated by Ph.D. or comparable post graduate qualification Age limits 25-27 years.

General analytical and research work in toxicologifood, drugs, industrial chemistry. Supervision of African Chemical staff.

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TERMS OF APPOINTMENT : Pensionable emoluments in the scale £816-£1,50 plus cost of living allowance at present 10%.

pius cost of living allowance at present 10%.

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Apply in writing to the DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, GREAT SMITH STREET, LONDON, S.W.1. giving bridge area qualifications and

LONDON, S.W.1., giving briefly age, qualifications and experience. Mention the reference number shown against the post applied for.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY, ALDERMASTON, BERKS, required SENIOR EXPERIMENTAL OFFICER to advise technical and scientific staff on safe working in laboratories, pilo plant, and production units associated with a wide rang of chemical and physical research problems. In successful applicant will act as deputy to the Establishment Safety Officer. Minimum qualification is Right School Certificate, but a pass degree in Chemistry, and previous experience of the control of staff and of wor on explosives is desirable. The scale of pay (minimum age 35) is £1,017-£1,197 per annum. The successful applicant will be required to join the Authority-Principal Superannuation Scheme to be introduced shortly, and the salary scale quoted above will be enhanced to cover contributions. Housing accommobinomy will be available within a reasonable period is married staff who live outside the Establishment rancing accommobination of the contribution will be available within a reasonable period is married staff who live outside the Establishment rancing accommobination of the contribution of the contributions. Application form from SEMB RECRUITMENT OFFICER, A.W.R.E., ALDERMASTON. plant, and production units associated with a wide range RECRUITM NT OFFICER, A.W.R.E., ALDERMASTON.

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SITUATIONS VACANT

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY, ALDERMASTON, BERKS, requires EXPERIMENTAL OFFICERS to assist technical and experimental officers to assist technical and scientific advisors with the surveillance of all aspects of safe working in laboratories, pilot plant and small production units associated with general chemical and physical research problems and advising on the implementation of standard codes of practice, and the development of new ones as necessary. Minimum qualification is Higher School Certificate, but a pass degree in Chemistry is desirable. Previous experience of the control of staff and for one post some experience of opay is (Minimum age 26) £715-£880 (nale) per annum. The successful applicants will be required to join the Authority's Principal Superannuation Scheme to be introduced shortly, and the salary scale quoted above will be enhanced to cover contributions. Housing accommodation will be available within a reasonable period for married officers, who live outside the radius of the Establishment's transport facilities. Application form from Senior Recruitment Officers, Atomic Weapons Research Establishment, Aldermaston, Berks. Quote Ref. 337/W.G.E./38. cientific advisors with the surveillance of all aspects of

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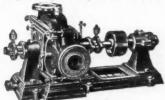
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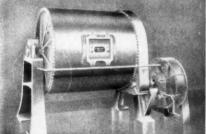
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